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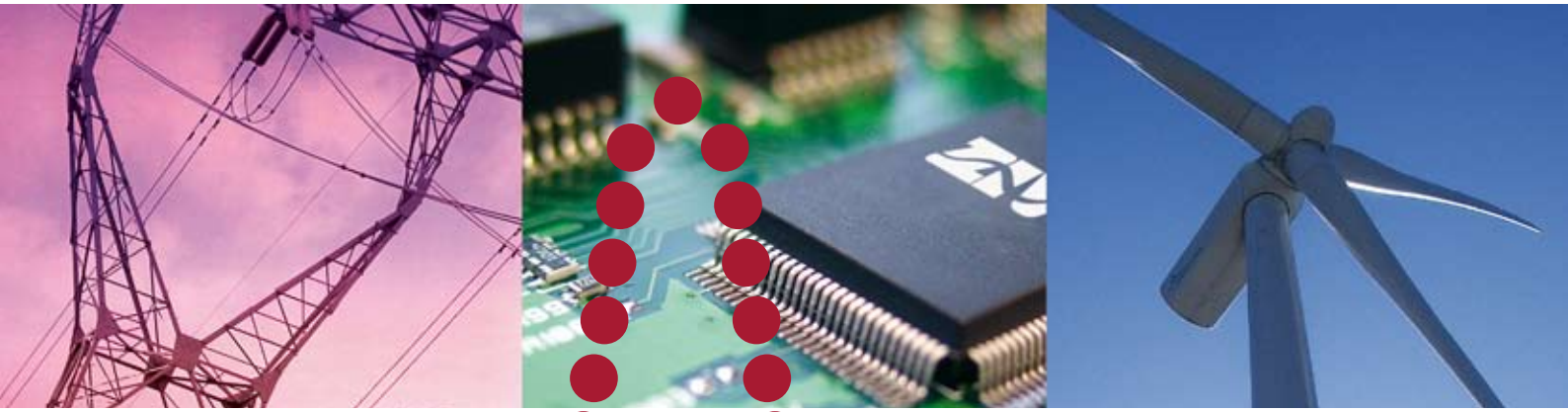

7IVD

Distribution Protection and Control

Instructions Manual

7IVD-J/K/L MODELS © ZIV GRID AUTOMATION, S.L. 2012

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The **7IVD** series is a family of IEDs for feeder or machine protection and control applications. This family is based on digital technology and adapts to all requirements imposed by the various possible configurations of MV electric IEDs in substations.

This family of equipment features the following functions: complete protection of a given bay; monitoring and annunciation (remote and optionally local) of all the devices associated to that bay: breaker, disconnecting switches, etc. with their corresponding interlockings; analog values metering (current, voltage, power...); capture of the field information associated with the bay through digital status contact inputs; possibility of setting up programmable control functions and local interlockings; **7IVD** systems are designed for medium voltage lines, transformers, generators and feeders in general where a protection, control and measurement device is required.

This Instruction Manual refers to models **7IVD-J**, **7IVD-K** and **7IVD-L** and specifies the corresponding characteristics in each case.

1.1 General Overview

7IVD IEDs are made up of two subsystems, the **protection** subsystem and the **control** subsystem. Consequently they perform protection and control functions. Both subsystems intercommunicate so that they can cooperate by information exchange, but always maintaining separate identities for any kind of action. The major features are:

- The IEDs have independent power supplies and microprocessors for protection and control.
- The communication ports available are common for both subsystems: protection and control.
- The auxiliary contact outputs as well as the digital status contact inputs are independent for protection and control.
- The protection measures analog inputs by means of circuits that are independent from the control circuits. Optionally, you can implement a measurement board exclusively dedicated to this function.

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1.2 Functions of the Protection Subsystem

1.2.1 3-Phase and Ground (3x50/51 + 50N/51N) Overcurrent Protection

All the models have four overcurrent measuring elements (three phase and one ground element). In models **7IVD-K** and **7IVD-L**, each IED contains a time element and an instantaneous element with an additional adjustable timer.

Each **7IVD-J** model IED is comprised of a time element and two instantaneous elements with an additional adjustable timer.

The time elements have five selectable time-current curves: **inverse**, **very inverse**, **extremely inverse**, **definite time** and a **user**-defined curve. The **7IVD-L** model has another two time-current curves: **long time-inverse** and **short time-inverse**.

There are settings for enabling or disabling the time and instantaneous elements for phases and ground. These phase and ground elements have three selectable setting groups (one active and two in reserve).

These models have independent LED targets for the pickup of the phase and ground time elements as well as independent LED targets for instantaneous and delayed trip that can be directed to the auxiliary outputs.

1.2.2 3-Phase and Ground (3x67+67N) Directional Overcurrent Protection (7IVD-L)

Model **7IVD-L** has four additional directional overcurrent measuring elements (three phase and one ground). Each unit contains a time element and an instantaneous element with an additional adjustable timer.

The time elements have seven selectable time-current curves: **inverse**, **very inverse**, **extremely inverse**, **short time-inverse**, **long time-inverse**, **fixed time** and one **user**-defined curve.

There are settings for enabling or disabling the time and instantaneous elements for phases and ground. These phase and ground elements have three selectable setting groups (one active and two in reserve).

These models have independent LED targets for the pickup of the phase and ground time elements as well as independent LED targets for instantaneous and delayed trip.

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1.2.3 Minimum Voltage Protection (3x27)

They have three undervoltage units; each of them has an instantaneous (common setting) element with an additional adjustable timer. The undervoltage units are activated or deactivated together.

1.2.4 Maximum Voltage Protection (3x59)

They have three overvoltage units; each of them has an instantaneous (common setting) element with an additional adjustable timer. The overvoltage units are activated or deactivated together.

1.2.5 Frequency Units

They have two frequency units associated with an analog voltage input. Each of them can function as an overfrequency or underfrequency unit with independent timing. Both elements are activated or deactivated together.

1.2.6 Breaker Failure Protection

The IED has a built-in (three-phase trip) breaker failure function, which sends trip commands to one or more other breakers.

1.2.7 Open Phase Unit

The function of this unit is to detect the opening of any of the phases and, if detected, to make the trip and eliminate unbalance.

1.2.8 Residual Current Detection Unit

The purpose of the residual current detection unit is to generate a trip as soon as it detects the circulation of zero sequence current (that does not reach the fault level) in a pre-set time interval. The circulation of this current indicates that there is an unbalance of currents in the installation.

1.2.9 Three-Phase Recloser Function

The recloser function offers the possibility of coordinating with an external protection device in addition to the IED's built-in protection. Reclosing sequences for phase and ground faults can be set independently.

Reclosing is selectable up to a maximum of four attempts with independent settings for recloser timers and reset times. The breaker position controls the reclosing sequence with the reclose initiate signal.

The trip elements and reclose attempts enabled during a fault clearing and reclosing sequence are selectable.

Manual closing can be initiated from the IED using its reclosing output contacts. The close command in this instance is supervised and controlled in the same way as any permissible automatic reclosing command following a trip from the protection elements.

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1.2.10 Maneuver Order Failure

The proper reception of the status change of the breaker is verified after each maneuver.

1.3 Functions of the Control Subsystem

Since the control subsystem is configurable, in general, it can have the following functions:

1.3.1 Local Bay Control with Indication of the Status and how to Maneuver on each of the Elements that Comprise it

By means of the keypad, you can act on each of the elements that comprise the bay. A pre-programmed logic governs these operations and always takes into account the signals that arrive from the protection subsystem and the equipment's status (local or remote control).

1.3.2 Local Recloser Control

You can enable or disable the recloser from the keypad or via communications. Before this command is executed, the logic decides whether or not it is feasible. If the order is not executed, a message appears and, if it is executed, the recloser symbol will change to the new status.

1.3.3 Local Control of the Ground Measurement Elements (Model 7IVD-L)

You can block or unblock the trip signaling of the ground measuring elements together from the keypad. Before this command is executed, the logic decides whether or not it is feasible. The symbol that represents the elements will indicate the new status.

1.3.4 Changing the Active Group (Model 7IVD-L)

You can change the active group from the keypad or via communications. Before this command is executed, the logic decides whether or not it is feasible. If the order is not executed, a message appears and, if it is executed, the enabling symbol will indicate the new status.

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1.3.5 Display of the Measurements

The graphic display presents the measurements (currents, voltages, powers...) that the control subsystem receives through the protection subsystem or from the measurement board.

1.3.6 Presentation of Local Alarms as Conventional Alarms

The graphic display can also present the information related to alarm signals. One of the screens displays the alarms processed in the logic, those that come from the protection subsystem and those that are directly obtained from analog input signals.

1.3.7 Indication of the Status of the Digital Inputs and Outputs

You can view all the control digital inputs and outputs on the screens of the graphic display.

1.3.8 Indication of the Status of the Auxiliary Outputs and Protection LEDs

You can view the status of all the auxiliary outputs and protection LEDs on the screens of the graphic display.

1.4 Additional Functions

- **Selecting the phase sequence (model 7IVD-L)**

The protection subsystem of the IEDs allows you to configure the measurement of the phase currents according to a sequence: ABC or CBA.

- **Trip and close circuit monitoring**

The IED's protection subsystem has elements to monitor the proper operation of the breaker's trip and close circuits. Both circuits are monitored in both breaker statuses (open and closed). The monitoring generates two digital outputs: trip circuit failure and close circuit failure.

- **Monitoring the switching outputs**

Associated with the functions of monitoring the trip and close circuits, the protection subsystem has functions that monitor the switching outputs (closure and trip).

- **Breaker maintenance monitoring**

To have information for maintaining the breaker, the IED's protection subsystem has an element that sums and accumulates the kA^2 values each time it trips.

- **Excessive number of trips**

This function, available in the protection subsystem, prevents the breaker from making an undesirable number of maneuvers in a given period of time that, as a result, possibly damaging the breaker.

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- **LED targets**

There are fourteen **LEDs**. Twelve of them are user-definable and the other two indicate the availability of the **protection** and **control** subsystems respectively. Of the twelve definable **LEDs**, four correspond to the protection subsystem and eight to the control subsystem.

- **Measurement board (optional)**

By using the measurement board, you have three analog current inputs and three analog voltage inputs and, therefore, the possibility of measuring currents, voltages, powers, energies, etc.

- **Protection and control digital status contact inputs**

The protection and control subsystems have a number of digital status contact inputs, depending on the model. Their function is determined by the settings programmed in the IED.

- **Protection and control auxiliary outputs**

The number of auxiliary outputs available depends on the **7IVD** model. The function of these auxiliary outputs is determined by the settings programmed in the IED.

- **Oscillography settings (optional)**

The oscillography settings serve two different functions: **retrieval** and **display**. In the **7IVD-L** model, it retrieves the analog magnitudes as well as the digital signals.

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- **Local information (alphanumeric display, keypad and graphic display)**

Use the push-buttons next to the graphic *display* or the keypad located next to the alphanumeric display to obtain information about the monitored bay.

Alphanumeric display:

- Modification and visualization of protection and control settings
- Protection operations:
  Elements picked up.
  Elements energized.
  Contact input and output status.
- Protection event recording (if the model has the oscillographic register function defined, these logs can only be viewed through communications):
  Sequence of events recording.
  Current log file (the **7IVD-L** model also saves the voltages, powers, power factor and energies).
- Measurements used by the protection subsystem.
  Phase and ground currents (and their angles in model **7IVD-L**).
  Currents of the three phases (and their angles in model **7IVD-L**).
  Phase-to-phase voltages (only for model **7IVD-L**).
  Maximum current (maximums and minimums in model **7IVD-L**).
  Maximum voltage (maximums and minimums in model **7IVD-L**)
  Positive and negative sequence currents (and zero sequence only for model **7IVD-L**)
  Active and reactive powers (apparent power only in model **7IVD-L**) and power factor
  Maximum and minimum powers (model **7IVD-L**)
  Frequency
  Energies (model **7IVD-L**)

Graphic display:

- Single-wire bay presentation
- Alarm panel
- Contact input and output status
- Measurements and counters

- **Self-test program**

A continuously running diagnostic self-test program verifies the correct operation of all the components.

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1.5 Model Selection

7IVD								K	
	1	2	3	4	5	6	7/8/9	10	11

1	**Functions**			
	J	3 x (2x 50)/51 + 2x50N/51N + 3 x 27 + 3 x 59 + 81 + 79	**L**	3 x 50/51 + 50N/51N + 3 x 67 + 67N + 3 x 27 + 3 x 59 + 81 + 79
	K	3 x 50/51 + 50N/51N + 3 x 27 + 3 x 59 + 81 + 79		
2	**Options**			
	0	Special Model	**2**	Oscillographic register
	1	Basic Model	**8**	Osc. Reg. with digital TOPS + Locator
3	**Nominal Current**			
	E	1A	**G**	5 A (Phase) + 1 A (Ground)
	F	5 A + Optional Ground	**N**	5A

4		Power Supply	Status Contacs Inputs	Monitoring Inputs		Power Supply	Status Contacs Inputs	Monitoring Inputs
	1	24-48 Vdc (±20%)	24-48 Vdc	24-48 Vdc	**3**	220-250 Vdc (±20%)	48-250 Vdc	250 Vdc
	2	110-125 Vdc (±20%)	24-125 Vdc	125 Vdc	**6**	90-250 Vdc/ac (±20%)	24-125 Vdc	125 Vdc

5	**Rated Voltage / Frequency / Language**			
	1	110 and 110 √3 Vac / 50 Hz / Spanish	**D**	120 and 120 √3 Vac / 60 Hz / Spanish
	3	120 and 120 √3 Vac / 60 Hz / English	**F**	120 and 120 √3 Vac / 60 Hz / Portuguese
	B	110 and 110 √3 Vac / 50 Hz / English		
6	**Communications**			
	1	RS232 + RS232	**5**	RS232 + RS485
	2	RS232 + Plastic F.O. (1mm)	**6**	RS232 + Plastic F.O. (double ring)
	4	RS232 + Glass F.O. (with ST)	**A**	RS232 + Glass F.O. ST double rear port
7/8/9	**Inputs / Outputs / Measurement Module** To be defined at factory			
10	**Enclosure**			
	K	4 U x 1 19" rack		
11	**Communications Protocol** To be defined at factory			

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- **Functions**

50	Phase Instantaneous Overcurrent.
51	Phase Time Overcurrent (inverse / definite).
50N	Ground Instantaneous Overcurrent.
51N	Ground Time Overcurrent (inverse / definite).
67	Phase Directional.
67N	Ground Directional.
27	Phase Undervoltage.
59	Phase Overvoltage.
81	Frequency Protection.
79	Recloser.

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2.1 Power Supply Voltage

7IVD power supplies are independent of auxiliary supply (one for each of the two subsystems and for the measuring board) and their values can be selected depending on the specific model:

24-48 Vdc (±20%)
110-125 Vdc (±20%)
220-250 Vdc (±20%)
90 - 250Vdc and **90 - 220Vac (-10% / +20%)**

Note: In case of power supply failure, a maximum interruption of 100 ms is allowed for 110 Vdc input.

2.2 Protection Subsystem

2.2.1 Power Supply Burden

Quiescent	**7 W**
Maximum	**20 W**

2.2.2 Current Analog Inputs

Rated value	**In = 5A** or **1A** (depending on the model)
Thermal withstand capability	**4 In** (continuously) **50 In** (during 3 s) **100 In** (during 1 s)
Dynamic limit	**240 In**
Current circuit burden	**In = 5 A <0.2 VA In = 1 A <0.05 VA**

2.2.3 Voltage Analog Inputs

Rated value	**Vn = 110 V** (50 Hz) or **120 V** (60Hz)
Thermal withstand capability	**2 Vn** (continuously)
Voltage circuit burden	**Vn = 110 V < 0.5 VA**

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2.2.4 Measurement Accuracy

Current	**< 5 % or 20 mA** (whichever is greater) for **In** = **1A** or **5A**
Voltage	**< 5 %**
Frequency	**< 0.005 Hz**

2.2.5 Time Measurement Accuracy

Definite and inverse time curve (UNE 21-136 and IEC 255)	**E = 5**% or **25 ms** (whichever is greater)

2.2.6 Repeatability

Operating time	**2 %** or **25 ms** (whichever is greater)

2.2.7 Transient Overreach

Expressed as: $ST = \frac{I_A - I_T}{I_A} x100$

<10% for totally inductive lines
<5% for lines with an impedance angle of 70º or less

I_A = Pick up value for a current with no dc component
I_T = Pick up value for a current with maximum dc offset

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2.2.8 Status Contact Inputs

Separate and configurable inputs with polarity.

Status contact input voltage range	
Input IN1	**110 Vac ±20 % or 125 Vdc 20%**
Inputs IN2 to IN8	**24 - 125 Vdc ±20 %**
(selectable range depending on the model)	**48 - 250 Vdc ±20 %**

Inputs IN5 to IN8 will be fed to a selectable voltage (depending on the model) when their application is to monitor the trip and/or close circuits.

Ranges available	**24 - 48 Vdc ±20%**
	125 Vdc ±20%
	250 Vdc ±20%
Current drain	**< 5 mA**

2.2.9 Trip and Close Outputs

2 contacts generally open, one of them internally definable to closed.

Make and carry	**30 A** during **1 s**
(with resistive load)	
Continuous	**8 A**
(with resistive load)	
Connection capability	**2500 W**
Breaking capability: (with resistive load)	**150 W** - max. 8 A - (up to 48 Vdc)
	55 W (80 Vdc - 250 Vcc)
	1250 VA
Breaking capability (L/R = 0.04 s)	**60 W** to 125 Vdc
Switching voltage	**250 Vdc**
Momentary close time	
trip contacts remain closed	**100 ms**

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2.2.10 Auxiliary Contact Outputs

Switched contacts open and closed and contacts generally open

Make and carry (with resistive load)	**5 A** for **30 s**
Continuous (with resistive load)	**3 A**
Connection capability	**2000 W**
Break (resistive)	**75 W** - (max. 3 A) up to (48 Vdc) **40 W** (80 Vdc - 250 Vdc) **1000 VA**
Break (L/R = 0.04 s)	**20 W** up to **125 Vdc**
Switching voltage	**250 Vdc**

2.3 Control Subsystem

2.3.1 Loads

Power Supply Burden

Quiescent	**9 W**
Maximum	**20 W**

Measurement Board Loads

Quiescent	**4 W**
Maximum	**9 W**

2.3.2 Status Contact Inputs

The number of digital status contact inputs depends on the model.

Rated voltage for status contact inputs	**24-125 Vdc ±20%** **48-250 Vdc ±20%**
Current drain	**< 5 mA**

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2.3.3 Double Contact Outputs (SD1 and SD2)

Make and carry (with resistive load)	**30 A** during **1 s**
Continuous (with resistive load)	**8 A**
Close:	**2500 W**
Breaking capability (with resistive load)	**150 W** -max**. 8 A**- (up to **48 Vdc**) **55 W** (**80 Vdc** - **250 Vdc**) **1250 VA**
Break (L/R = 0.04 s)	**60 W** to **125 Vdc**
Switching voltage	**250 Vdc**
Momentary close time: trip contacts remain open	**100 ms**

2.3.4 Single Contact Outputs

Make and carry (with resistive load)	**5 A** for **30 s**
Continuous (with resistive load)	**3 A**
Close	**2000 W**
Break (resistive)	**75 W** -max. **3A**- (up to **48 Vdc**) **40 W** (80 - **250 Vdc**) **1000 VA**
Break (L/R = 0.04 s)	**20 W** to **125 Vdc**
Switching voltage	**250 Vdc**

2.3.5 Converter Inputs / Outputs

Input impedance	**< 1kΩ**
Load impedance	**< 1kΩ**

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2.3.6 Measurement Accuracy (measurement board)

Measurement Accuracy	**< 0.5%**

2.3.7 Time Measurement Accuracy

Time Measurement Accuracy	**E = 5%** or **30 ms** (whichever is greater)

2.3.8 Current Input (measurement board)

Rated value	
Phase and ground elements	**In=5 A** or **1 A**
Thermal withstand capability	**4 In** (continuously) **50 In** (for 3 s) **100 In** (for 1 s)
Dynamic limit	**240 In**
Voltage circuit burden	**In=5A < 0.2 W**

2.3.9 Voltage Input (measurement board)

Rated value	**Depending on the model**
Thermal withstand capability	**2 In** (continuously**)**
Voltage circuit burden	**In = 110 V < 0.5 VA**

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2.4 Communication Data

Glass Fiber Optics	
Type	**Multimode**
Wavelength	**820 nm**
Connector	**ST**
Transmitter minimum power	
50/125 fiber	**- 20 dBm**
62.5/125 fiber	**-17 dBm**
100/140 fiber	**-7 dBm**
Receiver sensitivity	**-25.4 dBm**

Plastic Fiber Optics (1 mm)	
Wavelength	**660 nm**
Transmitter minimum power	**-16 dBm**
Receiver sensitivity	**-39 dBm**

RS232C Port Signals	
Front dB-9 connector, signals used	**Pin 2 - RXD** **Pin 3 - TXD** **Pin 5 - GND** **Pin 6 - DSR**
dB-25 connector, signals used	**Pin 2 - TXD** **Pin 3 - RXD** **Pin 4 - RTS** **Pin 5 - CTS** **Pin 7 - GND**

RS485C Port Signals	
Signals used	**A (B5)** **B (B6)**

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3. Standards and Type Test

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3.2 Electromagnetic Compatibility 3-2
3.3 Environmental Test 3-3
3.4 Power Supply 3-3
3.5 Mechanical Test 3-3

The equipment satisfies the requirements of IEC-255 (EN 21-136) at the maximum class for the values indicated below.

3.1 Insulation

Insulation Test (Dielectric Strength)	*IEC-60255-5*
Between all circuit terminals and ground	**2 kV**, **50 Hz**, for 1 min
Between all circuit terminals	**2 kV**, **50 Hz**, for 1min
Voltage Impulse Test	*IEC-60255-5*
	5 kV; **1.2/50 µs**; **0.5 J**

3.2 Electromagnetic Compatibility

1 MHz Burst Test	*IEC-60255-22-1 Class III*
Common mode	**2.5kV**
Differential mode	**1.0kV**
Fast Transient Disturbance Test	*IEC-60255-22-4 Class IV (IEC 61000-4-4)*
	4 kV ±10 %
Radiated Electromagnetic Field Disturbance	*IEC 61000-4-3 Class III*
Amplitude modulated	**10 V/m**
Pulse modulated	**10 V/m**
Conducted Electromagnetic Field Disturbance	*IEC 61000-4-6 Class III*
Amplitude modulated	**10 V**
Electrostatic Discharge	*IEC 60255-22-2 Class IV (IEC 61000-4-2)*
On contacts	**±8 kV ±10 %**

Radio Frequency Emissivity	*EN55022* (Radiated) *EN55011* (Conducted)

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3.3 Environmental Test

Temperature	*IEC 60255-6*
Operating range	From **-10º C** to **+ 55º C**
Storage range	From **-25º C** to **+ 70º C**
Humidity	**95 %** (non-condensing)

3.4 Power Supply

Power Supply Interference and Ripple	*IEC 60255-11* **< 20 %**

3.5 Mechanical Test

Vibration (sinusoidal)	*IEC-60255-21-1 Class I*
Mechanical Shock and Bump Test	*IEC-60255-21-2 Class I*

The models comply with the IEC 89/336 standard of electromagnetic compatibility.

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4. Physical Architecture

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4.3 Dimensions 4-4
4.4 Connection Elements 4-4
4.4.1 Terminal Blocks 4-4
4.4.2 Removing Printed Circuit Boards (Non Self-Shorting) 4-4

4.1 Modularity

- **Protection subsystem**

The protection subsystem has a board that provides the following functions:

- Power Supply.
- Central Processing Unit.
- Seven analog inputs (eight in model 7IVD-L)
- Eight digital status contact inputs
- Two tripping outputs
- Two closure outputs.
- Seven auxiliary outputs.
- Seven auxiliary outputs.
- An "in service" auxiliary output

These minimum features can be expanded with four analog inputs to double the number of digital status contact inputs and outputs (auxiliary, trip and closure).

- **Control subsystem**

The control subsystem, in turn, has a board that provides the following functions:

- Power Supply
- Central Processing Unit
- Eight digital status contact inputs
- Seven single contact digital
- Two double contact digital outputs
- Seven single contact digital outputs (two of them are switched)
- An "in service" output

Just as for the protection subsystem, you can expand this board with additional inputs and outputs. The IED can be configured to use all the available analog inputs and outputs or keep some in reserve.

The measured values that the control subsystem uses come either from metering transducers or from metering transformer secondaries. In the latter case, they can be physically captured and processed by the protection subsystem or by the measurement board and sent to the control subsystem through the interface that exists for this purpose.

Figure 4.1 illustrates the front of the IED with its alphanumeric and graphic displays, numeric and functional keypad and local communications port. Figure 4.2 shows the rear plate, which varies depending on the model. The figure indicates the location of the remote communications port and the connectors of the protection board, the control board, the measurement board and the eventual expansion boards.

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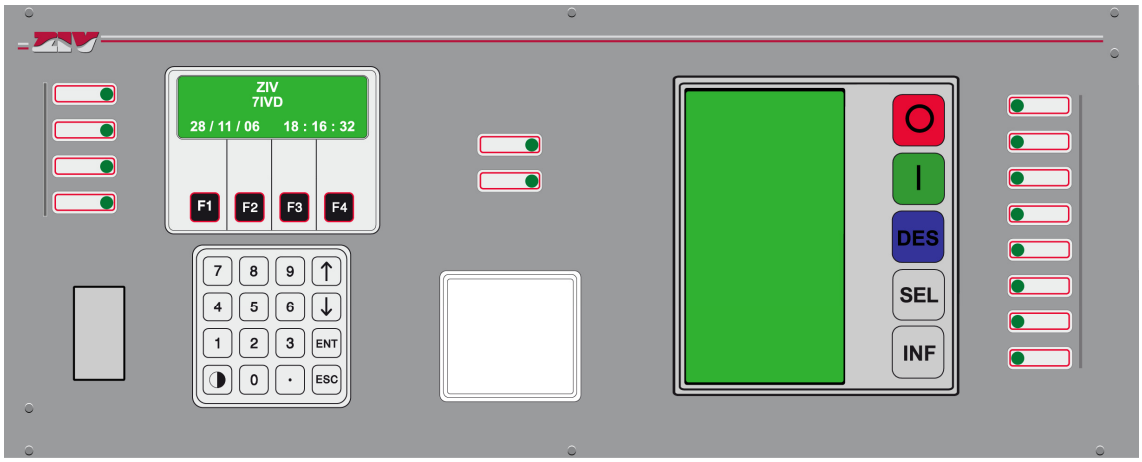

Figure 4.1: Front View of a 7IVD.

Figure 4.2 illustrates the back of a generic IED. If the control subsystem is expanded, the expansion board is located just above the control motherboard. The board at the top is that of the measurements module, which communicates directly with the control subsystem.

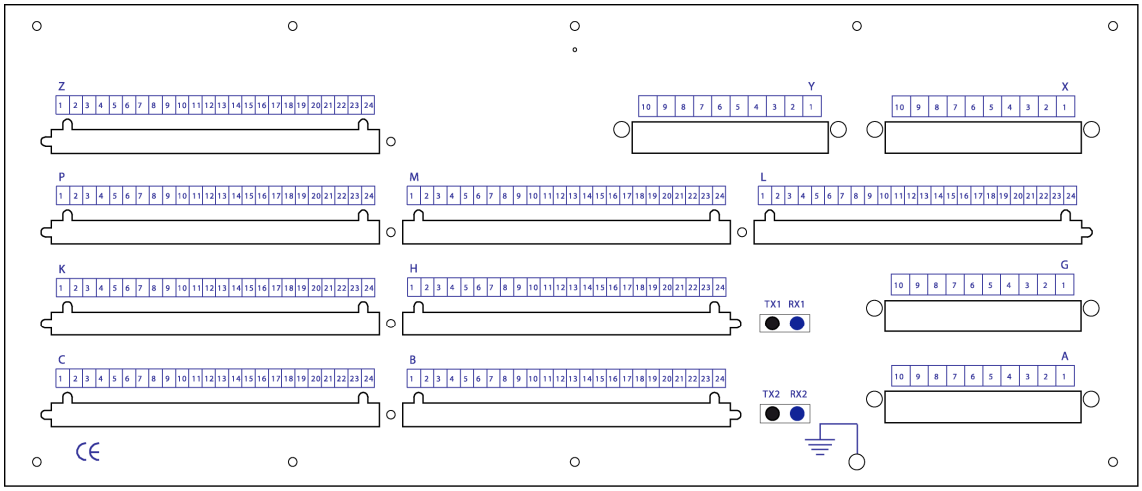

Figure 4.2: REAR View of a 7IVD.

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4.2 Protection and Control Interconnection

A communication interface between the two subsystems transmits data in both directions. This interface is made up of specific hardware and the corresponding software routines, which are resident in both systems and are responsible for the management and use of this hardware.

4.3 Dimensions

The IEDs are mounted in enclosures of 1 19" *rack* width and 4 rack heights. They are designed to be installed semi-flush mounted in panels. The enclosure is graphite grey.

4.4 Connection Elements

4.4.1 Terminal Blocks

The terminal blocks are arranged horizontally as shown in figure 4.2 and are distributed as follows:

- Protection board: 1 10-terminal block and 2 24-terminal connectors.
- Protection expansion board: 1 10-terminal blocks and 2 24-terminal blocks
- Control board: 1 10-terminal block and 2 24-terminal blocks
- Control expansion board: 3 terminal blocks with a maximum of 24 terminals.
- Measurement board: 2 10-terminal blocks and 1 24-terminal block.

The association of each terminal with the corresponding signals will depend on the IED settings.

The terminals of the 10-terminal block correspond to the current / voltage analog inputs and take #14 AWG – 2.5 mm^2 wires (maximum #11 AWG – 4 mm^2). The terminals of the 24-terminal block take #11 AWG – 2.5mm^2 wires. We recommend pin terminals for these connections.

4.4.2 Removing Printed Circuit Boards (Non Self-Shorting)

The IED's electronic boards are removable.

Warning! The current connector is non self-shorting. Consequently, the CT secondaries must be short-circuited externally before board removal.

The electronic boards have screws that must be taken out before removing them. It is also necessary to remove the screws from the terminal blocks.

Warning!This operation always requires the protection to be NOT IN SERVICE.

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5. Settings

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5.2.2 General Settings 5-14
5.2.3 Time Settings 5-14
5.2.4 Logic Settings 5-15
5.2.5 Analog Settings 5-15

5.1 Protection Subsystem Settings

5.1.1 Configuration Settings

Passwords
The factory-specified access password (full access) is 2140. Nevertheless, you can change the password to access the following options with the keypad: **Configuration**, **Operations** and **Settings**.

Local Control Permissions	
Setting	**Range**
Breaker / recloser / ground measurement elements (**7IVD-L**) from	
Local keypad	YES / NO
Front port	YES / NO
Remote port	YES / NO
Remote configuration from	
Remote port	YES / NO
Status contact inputs	YES / NO

Configuration of Digital Inputs, Outputs and LED Targets
The IED leaves the factory with a defect configuration for the digital inputs, outputs and LED targets. If you want to change these default settings, access them through the local port via the communications program ***ZIVercom*®.** If you want a different configuration, you can also request it ex factory.

Phase Sequence (Model 7IVD-L)	
Setting	**Range**
Phase Sequence	ABC / CBA

Language	
Setting	**Range**
Language	Spanish English Portuguese

Frequency (Model 7IVD-L)	
Setting	**Range**
Frequency	50 / 60 Hz

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5.1.2 General Settings

General Settings		
Setting	**Range**	**Step**
Relay in service	YES / NO	
Current transformation ratio phase	1 - 3000	1
Current transformation ratio ground	1 - 3000	1
Voltage transformer ratio phase	1 - 3000	1
Open breaker status	1 - 0 (*)	
Event masking (only via communications)	YES / NO	

(*) Positive on input or not.

5.1.3 Current Protection Settings

Phase Time Overcurrent Element		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.2 - 2.4) In	0.01A
Time curve	Definite time Inverse Very inverse Extremely inverse User-defined curve Inverse long time (*) Inverse short time (*)	
Time dial	0.05 - 1	0.01
Definite time delay	0.05 - 100s	0.01s
Torque control (Enable pickup blocking)	YES / NO	

(*) Only 7IVD-L Model.

Ground Time Delay Element		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.04-0.48) In	0.01 A
Time curve	Definite time Inverse Very inverse Extremely inverse User-defined curve Inverse long time (*) Inverse short time (*)	
Inverse time characteristic rate	0.05 - 1	0.01
Definite time delay	0.05 - 100s	0.01s
Torque control (enable pickup blocking)	YES / NO	

(*) Only 7IVD-L Model.

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Directional Phase Time Delay Element (7IVD-L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.2-2.4) In	0.01 A
Time curve	Definite time Inverse Very inverse Extremely inverse User-defined curve Inverse long time Inverse short time	
Time dial	0.05 - 1	0.01
Definite time delay	0.05 - 100 s	0.01
Torque control (Enable pickup blocking)	YES / NO	

Directional Ground Time Delay Element (7IVD-L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.04-0.48) In	0.01 A
Time curve	Definite time Inverse Very inverse Extremely inverse User-defined curve Inverse long time Inverse short time	
Time dial	0.05-1	0.01 s
Definite time delay	0.05-100 s	0.01
Torque control (Enable pickup blocking)	YES / NO	

Instantaneous Phase Overcurrent Elements 1 and 2 (7IVD-J) / Instantaneous Phase Overcurrent Element (7IVD-K/L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.1 - 30) In	0.01 A
Time delay	0 - 100s	0.01 s
Torque control (enable pickup blocking)	YES / NO	

Ground Instantaneous Overcurrent Elements 1 and 2 (7IVD-J) / Ground Instantaneous Overcurrrent Element (7IVD-K/L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.1 - 12) In	0.01 A
Time delay	0 - 100s	0.01 s
Torque control (enable pickup blocking)	YES / NO	

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Directional Phase Instantaneous Element (7IVD-L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.1-30) In	0.01 A
Time delay	0 - 100 s	0.01 s
Torque control (enable pickup blocking)	YES / NO	

Directional Ground Instantaneous Element (7IVD-L)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.1-12) In	0,01A
Time delay	0-100 s	0.01 s
Torque control (enable pickup blocking)	YES / NO	

Directional Element (7IVD-L)		
Setting	**Range**	**Step**
Characteristic phase angle	15º – 85º	1º
Characteristic ground angle	15º – 85º	1º
Blocking by lack of polarization	YES/NO	

Residual Current Detection Element		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.02-0.48) In	0,01A
Time delay	0.05-300 s	0,01s

Open Phase Element		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	(0.05-0.4) I_2/I_1(	0.05
I_2 = negative-sequence current element		
I_1 = positive-sequence current element		
Minimum load in the line (model 7IVD-L)	(0.02-1) In	0.01 A
Time delay	0.05 - 300 s	0.01 s

Breaker Failure Element		
Setting	**Range**	**Step**
Enable (Permission)	YES/NO	
Phase reset	(0.04-0.48) In	0.01 A
Ground reset	(0.04-0.48) In	0.01 A
Time delay	0.05-0.70 s	0.01 s

Note: the pickup ranges of the elements are given in terms of In (5A or 1A). For example, for 5A the range of the phase timer would be (1 - 12A).

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5.1.4 Voltage Elements Settings

Undervoltage Element (27)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	50 - 140 V	
Time delay	0 - 300 s	0.01
Type of operation	OR / AND (1/0)	

Overvoltage Element (59)		
Setting	**Range**	**Step**
Enable (Permission)	YES / NO	
Pickup	50 - 140 V	
Time delay	0 - 300 s	0.01
Type of operation	OR / AND (1/0)	

Frequency Elements		
Setting	**Range**	**Step**
Enable (common to elements 1 & 2)	YES/NO	
Pickup (elements 1 & 2 independent)	40 - 70 Hz	0.01 Hz
Time delay (elements 1 & 2 independent)	0.005 - 20 s	0.001 s
Type of operation (elements 1 & 2 independent)	Max. Freq / Mín. Freq. (0/1)	
Disable by min. voltage (common to elements 1 & 2)	40% - 100% of Vn	

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5.1.5 Recloser Settings

Recloser in Service	
Setting	**Range**
Recloser in Service	YES / NO

Recloser Timers(independent for each of the sequences)		
Setting	**Range**	**Step**
For interphase faults	0.2 - 300 s	0.01 s
For ground faults	0.2-300 s	0.01 s

Reclose Sequence Control Timers		
Setting	**Range**	**Step**
Rated voltage delay time	0.5 - 300 s	0.01 s
Reclose inhibit time delay	0.05 - 300s	0.01 s
Reset time for interphase faults	0.05 - 300 s	0.01 s
Reset time for ground faults	0.05 - 300 s	0.01 s
Safety margin after a manual closure	0.05 - 300 s	0.01 s
Sequence check time	0.05 - 0.35 s	0.01 s
Time delay on manual close	0.05 - 300 s	0.01 s

Reclose Sequence Control	
Setting	**Range**
Number of reclose attempts	1 - 4
Manual close supervision by rated voltage	YES / NO
Reclose supervision by rated voltage	YES / NO
Manual close supervision by reclose inhibit	YES / NO
Reclose supervision by reclose inhibit	YES / NO
Reclose inhibit time	YES / NO

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Trip permissions	
Setting	**Range**
Model 7IVD-J	
Phase instantaneous 1 (PI1)	YES / NO
Phase timer (PT)	YES / NO
Ground instantaneous 1 (GI1)	YES / NO
Ground timer (GT)	YES / NO
Undervoltage (27)	YES / NO
Overvoltage (59)	YES / NO
Frequency (F1 and F2)	YES / NO
Open phase element (OP)	YES / NO
Residual current (DN)	YES / NO
Phase instantaneous 2 (PI2)	YES / NO
Ground instantaneous 2 (GI2)	YES / NO
Model 7IVD-K	
Phase instantaneous (PI)	YES / NO
Phase timer (PT)	YES / NO
Ground instantaneous (GI)	YES / NO
Ground timer (GT)	YES / NO
Undervoltage (27)	YES / NO
Overvoltage (59)	YES / NO
Frequency (F1 and F2)	YES / NO
Open phase element (OP)	YES / NO
Residual current (DN)	YES / NO
Model 7IVD-L	
Phase instantaneous (PI)	YES / NO
Phase timer (PT)	YES / NO
Ground instantaneous (GI)	YES / NO
Ground timer (GT)	YES / NO
Undervoltage (27)	YES / NO
Overvoltage (59)	YES / NO
Frequency (F1 and F2)	YES / NO
Open phase element (OP)	YES / NO
Residual current (DN)	YES / NO
Directional phase instantaneous (DPI)	YES / NO
Directional phase time delay (DPT)	YES / NO
Directional ground instantaneous (DGI)	YES / NO
Directional ground time delay (DGT)	YES / NO
Recloser states for which these permissions are defined	
Trip in default condition Trip reset time 1st, 2nd, 3rd and 4th sequences Trip reset time external manual close Trip reset time close through the recloser	

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Reclosing permissions	
Setting	**Range**
Model 7IVD-J	
Phase instantaneous overcurrent 1 (PI1)	YES / NO
Phase time overcurrent (PT)	YES / NO
Ground instantaneous overcurrent 1 (GI1)	YES / NO
Ground time overcurrent (GT)	YES / NO
Open phase (OP)	YES / NO
Residual current (DN)	YES / NO
Operation of external protection (EP)	YES / NO
Model 7IVD-K	
Phase instantaneous overcurrent 1 (PI)	YES / NO
Phase time overcurrent (PT)	YES / NO
Ground instantaneous overcurrent 1 (GI)	YES / NO
Ground time overcurrent (GT)	YES / NO
Open phase (OP)	YES / NO
Residual current (DN)	YES / NO
Operation of external protection (EP)	YES / NO
Model 7IVD-L	
Phase instantaneous overcurrent 1 (PI)	YES / NO
Phase time overcurrent (PT)	YES / NO
Ground instantaneous overcurrent 1 (GI)	YES / NO
Ground time overcurrent (GT)	YES / NO
Open phase (OP)	YES / NO
Residual current (DN)	YES / NO
Operation of external protection (EP)	YES / NO
Directional phase instantaneous overcurrent (DPI)	YES / NO
Directional phase time overcurrent (DPT)	YES / NO
Directional ground instantaneous overcurrent (DGI)	YES / NO
Directional ground time overcurrent (DGT)	YES / NO
Recloser states for which these permissions are defined	
Trip reclose with the recloser in default condition	
Trip reclose after the reset time of 1st, 2nd, 3rd and 4th sequences	

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5.1.6 Logic Settings

Logic		
Setting	**Range**	**Step**
Trip output seal-in enable	YES / NO	
Breaker open failure time	0.02 - 2s	0.01s
Breaker close failure time	0.02 - 2s	0.01s
Recloser manual close enable	YES / NO	
Coordination time (model 7IVD-L)	(0 - 6) x 5 ms	1

5.1.7 Breaker Monitor Settings

Breaker Monitor Settings	
Setting	**RangE**
Excessive number of trips	1 - 40
I square sum alarm	0 - 99,999.99kA^2
Cumulative preset value I2 (setting and information)	0 - 99,999.99kA^2
Close circuit supervision enable	YES / NO*
Trip circuit supervision enable	YES / NO*

(*) Depending on the setting chosen (YES/NO), you must change the internal jumpers on the input/output board (see figure 5.1)

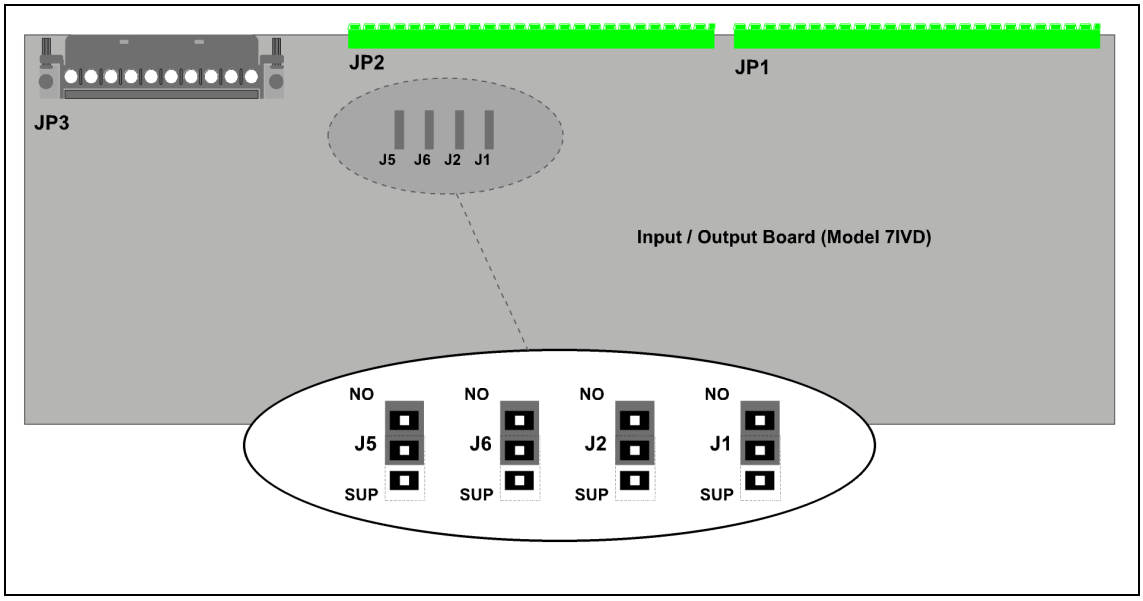

Figure 5.1: Monitoring Jumpers for Model 7IVD.

Inputs / jumpers correspondence	
Contact inputs	**Model 7IVD**
IN5	J1
IN6	J2
IN7	J6
IN8	J5

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5.1.8 History Log

History Log	
Setting	**Range**
Average calculation time interval	1 - 15 min
Logging interval	from 1 min. to 24.00 h.
Day calendar mask	Monday through Sunday (YES/NO)
Hour range	from 0 to 24.00 h

5.1.9 Oscillography Settings (optional)

Oscillography Settings	
Setting	**Range**
Recording mode (Fixed time) YES = fixed time NO= variable time	YES / NO
Overwrite	YES / NO
Type of Start	Pickup Trip 1 Trip 2

Pickup function	
Setting	**Range**
Phase time overcurrent (PT)	YES / NO
Ground time overcurrent (GT)	YES / NO
Phase inst. overcurrent (PI)*	YES / NO
Ground inst. overcurrent (GI)*	YES / NO
Directional phase time delay (DPT)**	YES / NO
Directional ground time delay (DGT)**	YES / NO
Directional phase inst. (DPI)**	YES / NO
Directional ground inst. (DGI)**	YES / NO
Open phase (OP)	YES / NO
Residual current (DN)	YES / NO
Open command (OC)	YES / NO
Ext. oscillography start (EX)	YES / NO
Overvoltage element (59)	YES / NO
Undervoltage element (27)	YES / NO
Frequency element 1 (F1)	YES / NO
Frequency element 2 (F2)	YES / NO

*** The mask of the instantaneous phase and ground overcurrent elements is common for instantaneous elements 1 and 2 in model 7IVD-J.**
**** The masks of the directional instantaneous and delayed elements apply exclusively to model 7IVD-J.**

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Channels		
Setting	**Range**	**Step**
Pre-pickup	1 -2 cycles	1
Length of the oscillograph	20 -300 cycles	1
Analogic channels 0-6 (seven channels) 1 2 3 4 5 6 7 Ia Ib Ic In Va Vb Vc 0-7 (eight channels) (7IVD-L) 1 2 3 4 5 6 7 8 Ia Ib Ic In Va Vb Vc Ipol		

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5.2 Control Subsystem Settings

5.2.1 Configuration settings

Passwords
The access password specified ex factory is 2140. Nevertheless, you can change the password to access the following options: Password 1: Configuration Password 3: Settings

Configuration of the Remote Port		
Setting	**Range**	**Step**
IED address	0 - 254	1
Baud rate	300 - 19200 bauds	
Stop bits	1 - 2	
Parity	0 (no parity) - 1 (even parity)	
Communications timeout	0 - 1000 ms	

Configuration of the Local Port (fixed setting)	
Setting	**Range**
IED address	Answers to all
Baud rate	4800 bauds
Stop bits	1
Parity	Even

Configuration of the Front and Remote Protection Ports (7IVD-L)	
Setting	**Range**
Front port parity	0 (no parity) - 1 (even parity)

Rated frequency (model 7IVD-L)	
Setting	**Range**
Rated frequency	50 - 60 Hz

Date and time
Updatable from the keypad

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5.2.2 General Settings

General Settings		
Setting	**Range**	**Step**
Current transformer ratio	1 - 3000	
Voltage transformer ratio	1 - 3000	
Converter inputs/outputs (*)	0.00 to 99999.99	
Constant	kw, kVAr, A, kV	
Magnitude	±2.5; 0-5; ±1.0; 0-1; 4-20 mA	
Type	±125 Vdc; ±48 Vdc; ±100 mVdc	

(*)Remember that the type of input converter is directly linked to the IED model and its hardware.

5.2.3 Time Settings

Time Settings	
Setting	**Range**
Unknown time 52	0.00 to 30.00 s
Unknown time 89	0.00 to 30.00 s
Command failure time 52	0.00 to 10.00 s
Failure time 89	0.00 to 20.00 s
Pulse duration	0.00 to 5.00 s
Voltage presence time	0.00 to 15.00 s
Command output pulse	0.00 to 5.00 s
Duration of temporary lockout	0.00 to 180.00 s
Spring loading time	0.00 to 30.00 s
Trip step time	0.5 to 1.00 s
Failure time 79	0.00 to 10.00 s
Voltage absence time	0.00 to 15.00 s
Command failure time 89	0.00 to 30.00 s
Programmable control function command failure time	0.00 to 5.00 s
Temporary lockout time 90	0.00 to 120 s

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5.2.4 Logic Settings

Logic Settings	
Setting	**Range**
Command blocking time	YES / NO
Seal-in enable	YES / NO
Load shedding enable	YES / NO
Load shedding priority	YES / NO

5.2.5 Analog Settings

Analog Settings	
Setting	**Range**
Voltage presence level	10 to 110 Vac
Voltage absence level	10 to 85 Vac

Note: the above logic and analog time settings are only an example of possible settings, because the settings depend on the configuration of the IED.

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6.1 Overcurrent Elements

The **7IVD-J**, **7IVD-K** and **7IVD-L** type IEDs have four overcurrent protection elements: three phase and one ground element.

Model 7IVD-J

Each model **7IVD-J** IED contains an overcurrent time delay element and two instantaneous elements with an additional adjustable timer. The types of settings are: phase timer, ground timer, phase instantaneous 1, ground instantaneous 1, phase instantaneous 2 and ground instantaneous 2. Figure 6.6 is the block diagram of one of these IEDs.

Model 7IVD-K

Each **7IVD-K** IED contains an overcurrent time delay element and an instantaneous element with an additional adjustable timer. The types of settings are: phase timer, ground timer, phase instantaneous and ground instantaneous. Figure 6.7 is the logic diagram of one of these IEDs and shows its basic operation.

Model 7IVD-L

Each model **7IVD-L** IED contains two time delay overcurrent elements (one of them is directional) and two instantaneous elements with an additional adjustable timer (one of them is directional). The types of settings are: phase timer, ground timer, phase instantaneous, ground instantaneous, directional phase time overcurrent, directional ground time overcurrent, directional phase instantaneous overcurrent and directional ground instantaneous overcurrent. Figure 6.7 is the logic diagram of one of these IEDs and shows its basic operation.

6.1.1 Time Overcurrent

The overcurrent time delay function operates on the RMS of the input current. Pickup occurs when the value measured exceeds 1.05 times the pickup setting and resets at the pickup setting.

Pickup activation enables the timing function, which integrates the values measured. This is done by incrementing a counter according to the input current to determine the operation of the time element.

When the RMS falls below the pickup setting, a rapid reset of the integrator occurs. The activation of the output requires that the pickup continue throughout the integration time; any reset returns the integrator to its initial conditions so that a new operation initiates the time count from zero.

You can select the time curve from among three (five for the **7IVD-L)**) inverse functions (inverse, very inverse, extremely inverse and long time-inverse [**7IVD-L)**], short time-inverse [**7IVD-L)**]) and one definite time curve. You can add a user-defined time curve to these and load it on the relay via the communications system. The time setting, in the inverse time curves, is composed of two values: curve type and index within the family.

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6.1.1.a Current / Time Curve: Inverse Functions

Figures 6.1, 6.2, 6.3, 6.4 and 6.5 present the inverse curves available by the protection.

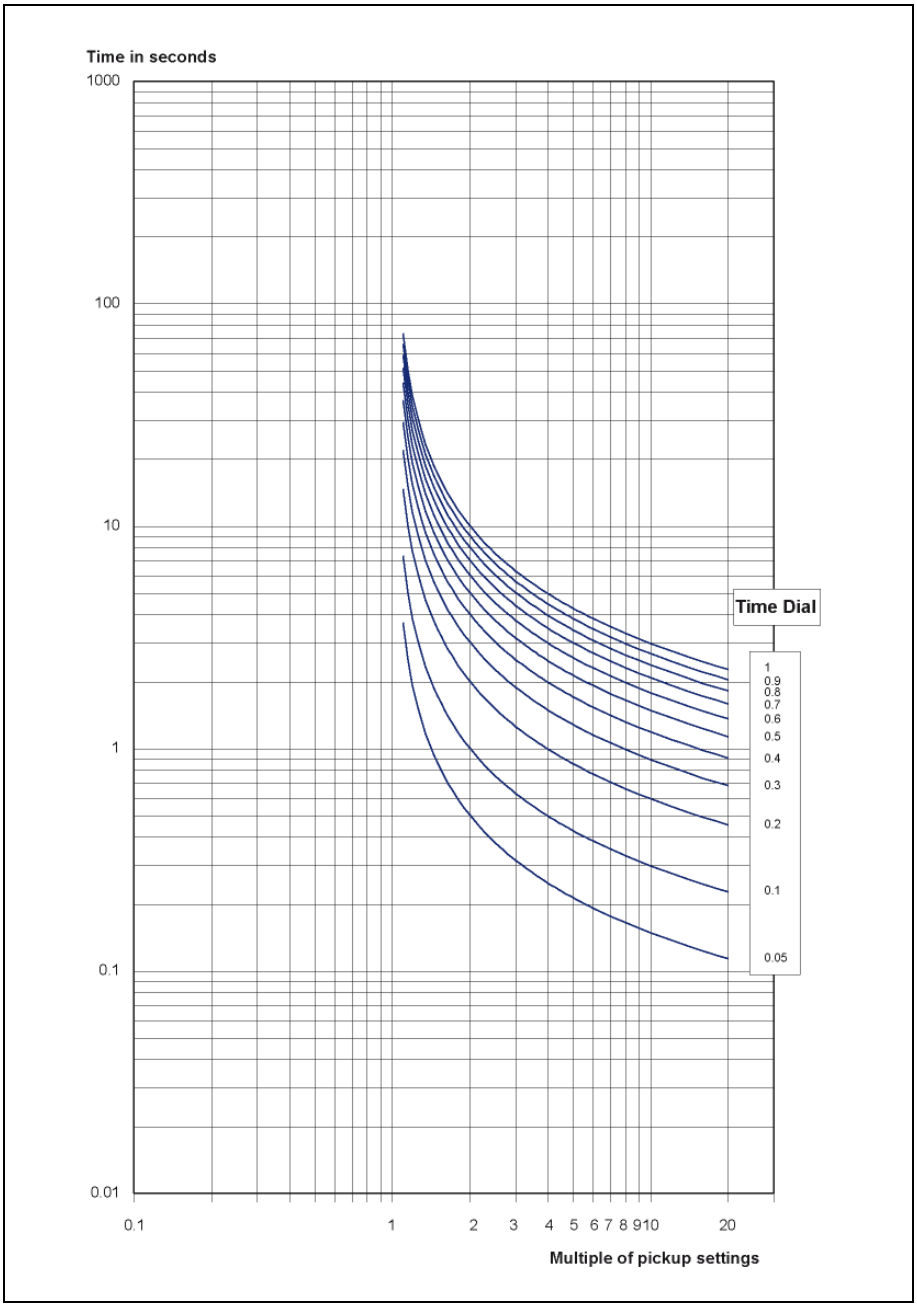

Figure 6.1: Inverse Time Curve.

$$t = \frac{0.14}{I_S^{0.02} - 1}$$

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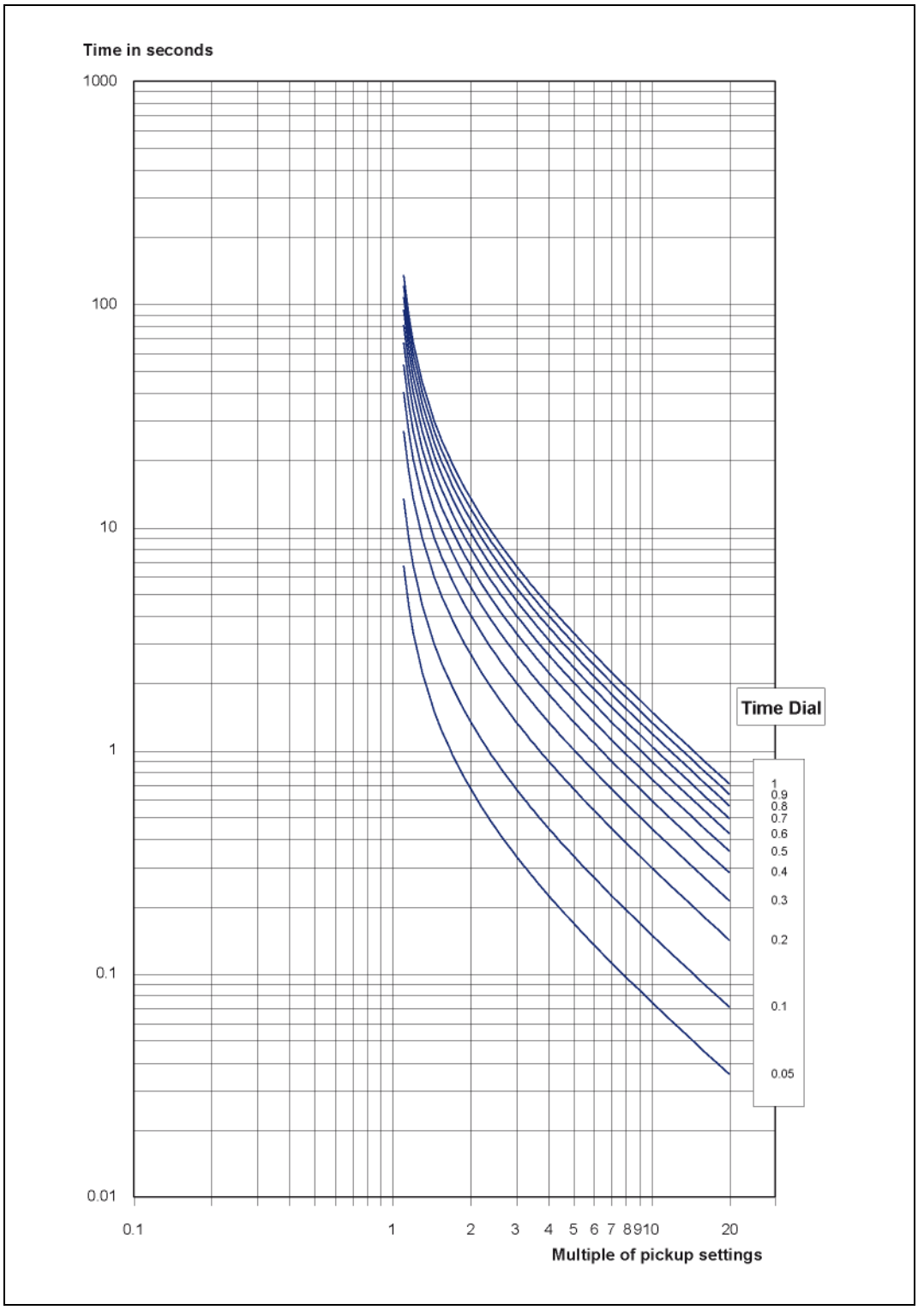

Figure 6.2: Very Inverse Time Curve.

$$t = \frac{13.5}{I_S - 1}$$

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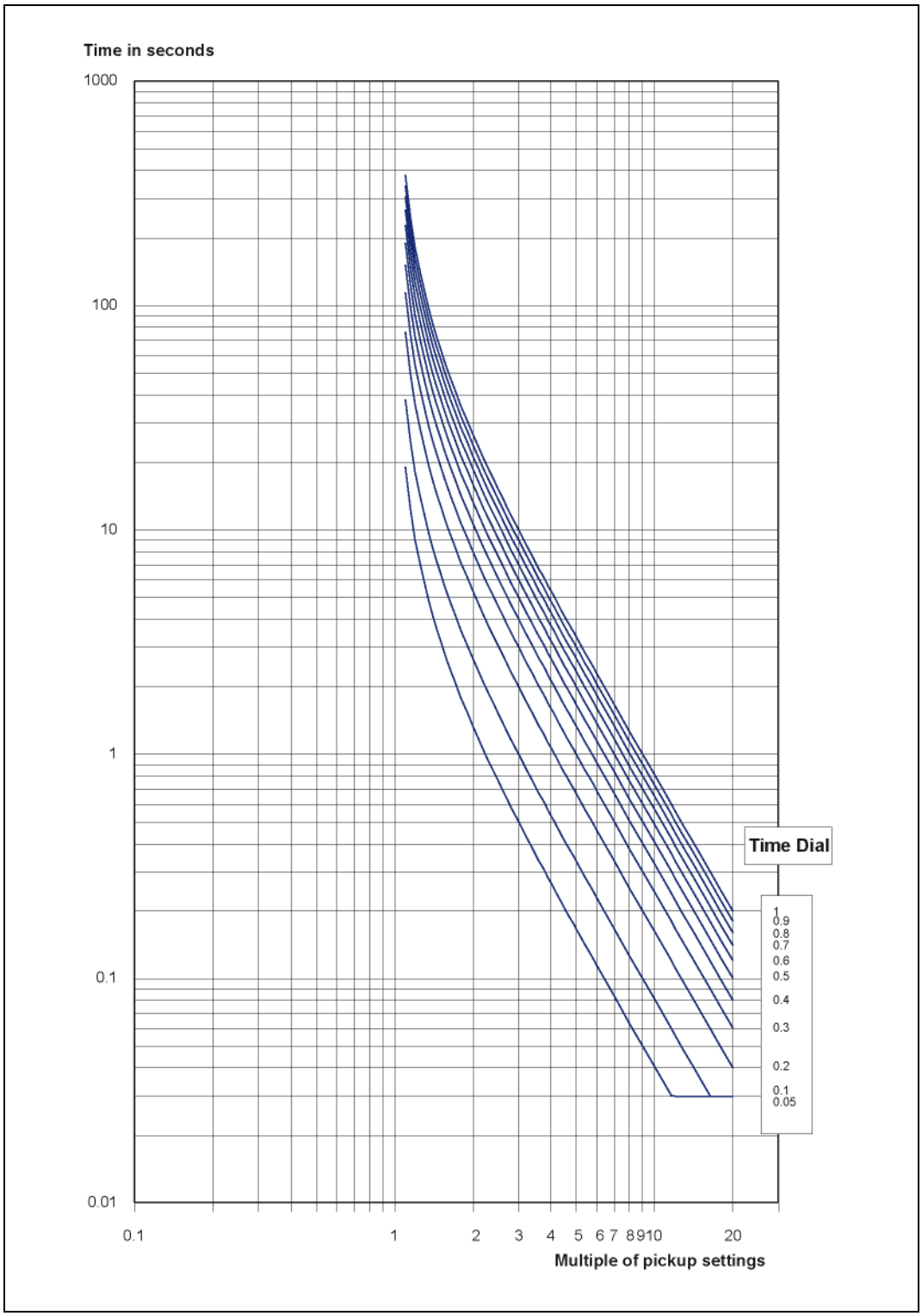

Figure 6.3: Extremely Inverse Time Curve.

$$t = \frac{80}{I_S^{\,2} - 1}$$

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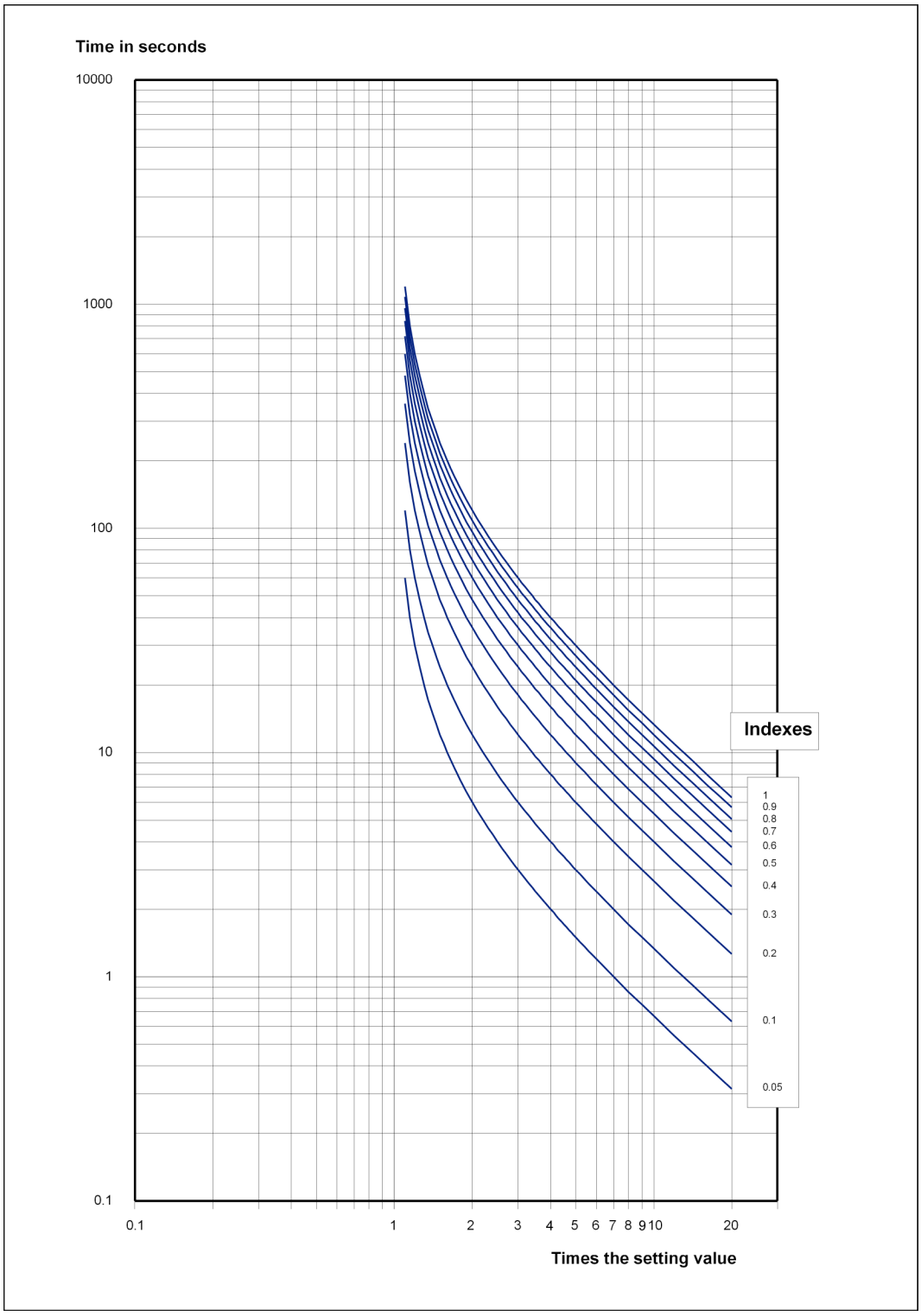

Figure 6.4: Long Time-Inverse Curve.

$$t = \frac{120}{I_S - 1}$$

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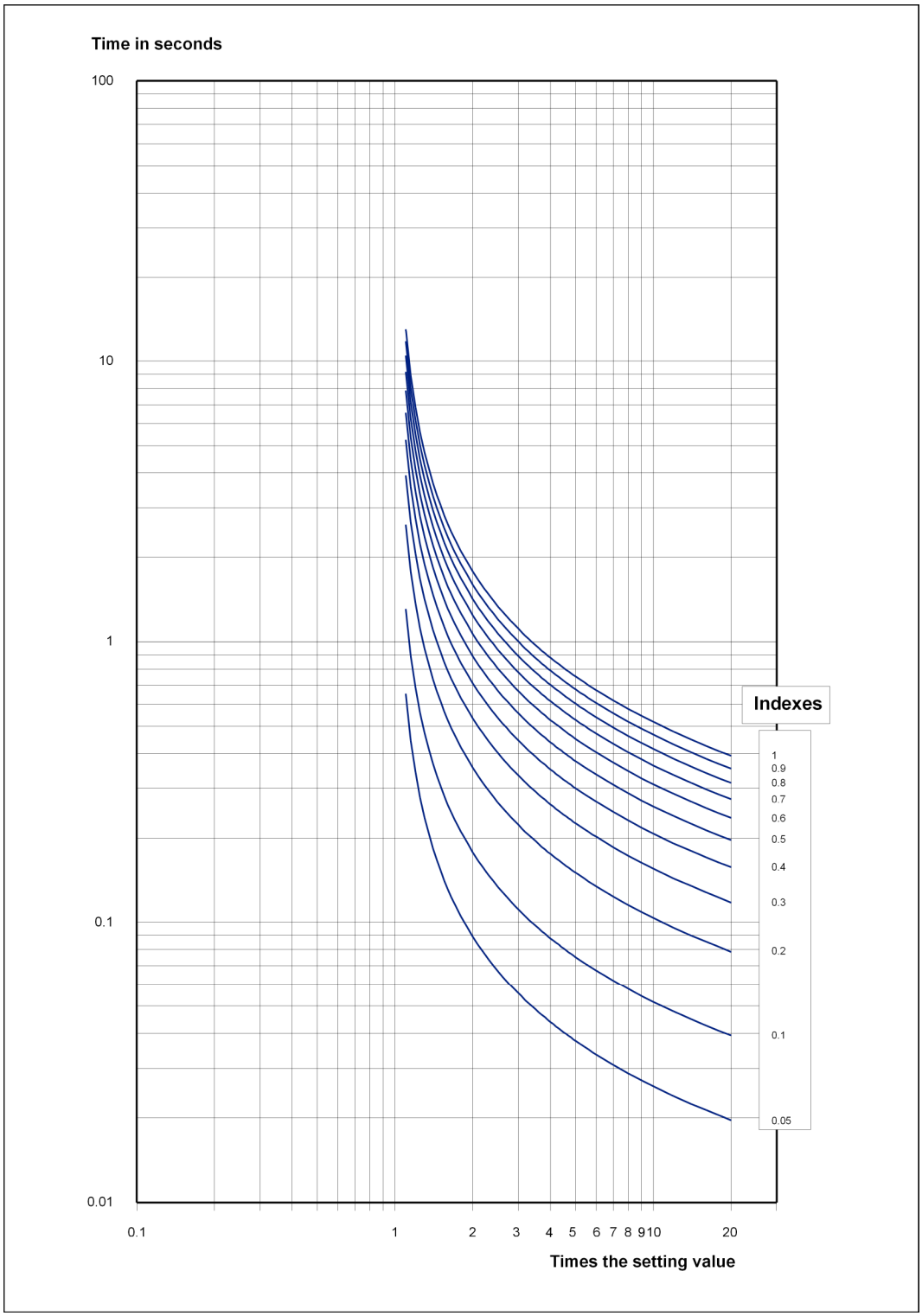

Figure 6.5: Short Time-Inverse Curve.

$$t = \frac{0.05}{I_s^{0.04} - 1}$$

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6.1.2 Instantaneous Overcurrent

The instantaneous elements work according to two different current measuring criteria: RMS value and peak-to-peak value. In the first case, operation takes place when the RMS exceeds 1.05 times the pickup setting. In the second case, it occurs when the difference between the values sampled at 180º exceeds 2.1 times the peak value of the pickup setting and the RMS detector has reset. In both cases the value is reset to the pickup setting.

Combining these two measurement methods with the filtering of the DC offset yields a low transient overreach without changes to the operating time.

Each of these elements has an adjustable timer at the output that allows the optional delay of the instantaneous elements.

Note that when **instantaneous element 2** trips either phase or ground in model **7IVD-J**, it inhibits the operation of the **recloser**.

6.1.3 Block Diagrams of the Overcurrent Elements

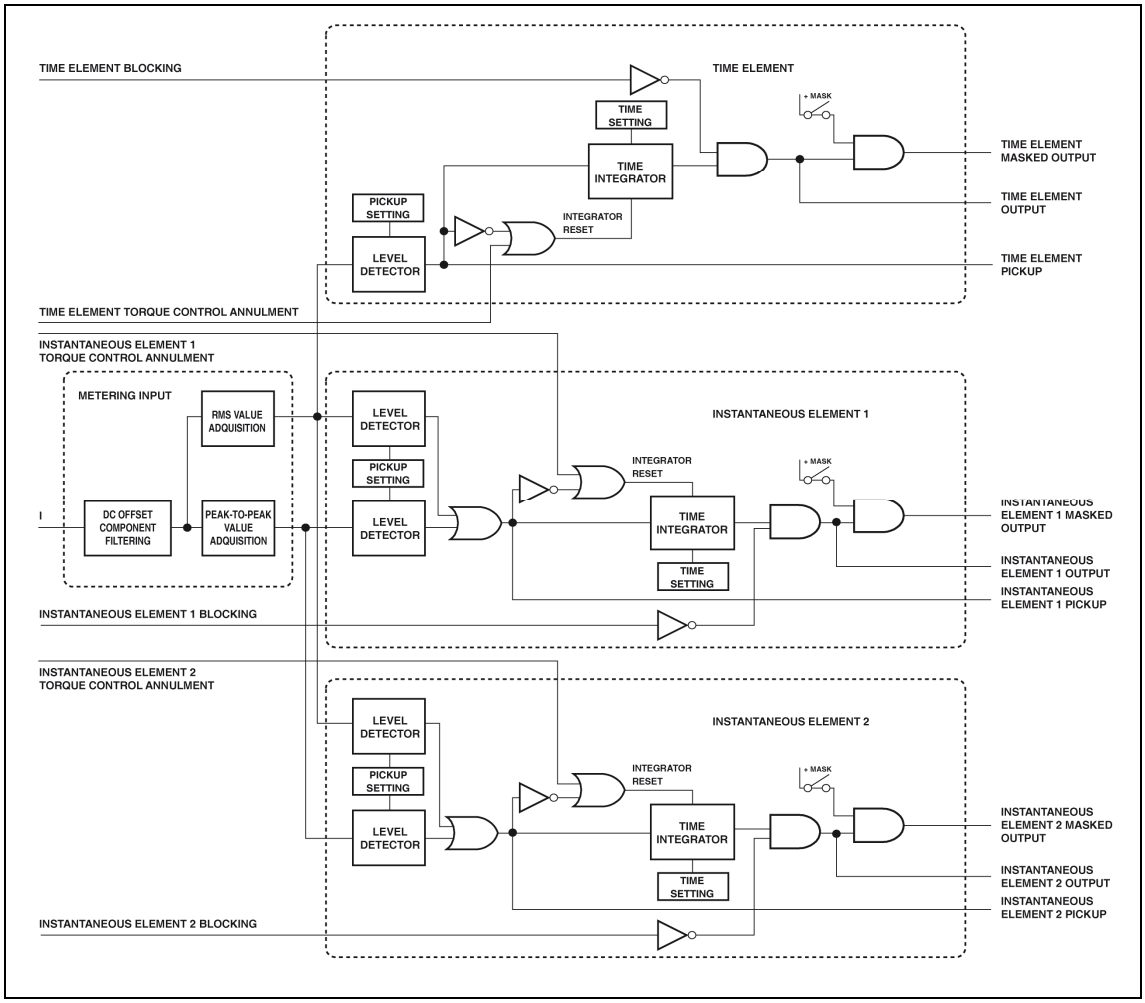

Figure 6.6: Overcurrent Unit Block Diagram (7IVD-J Model).

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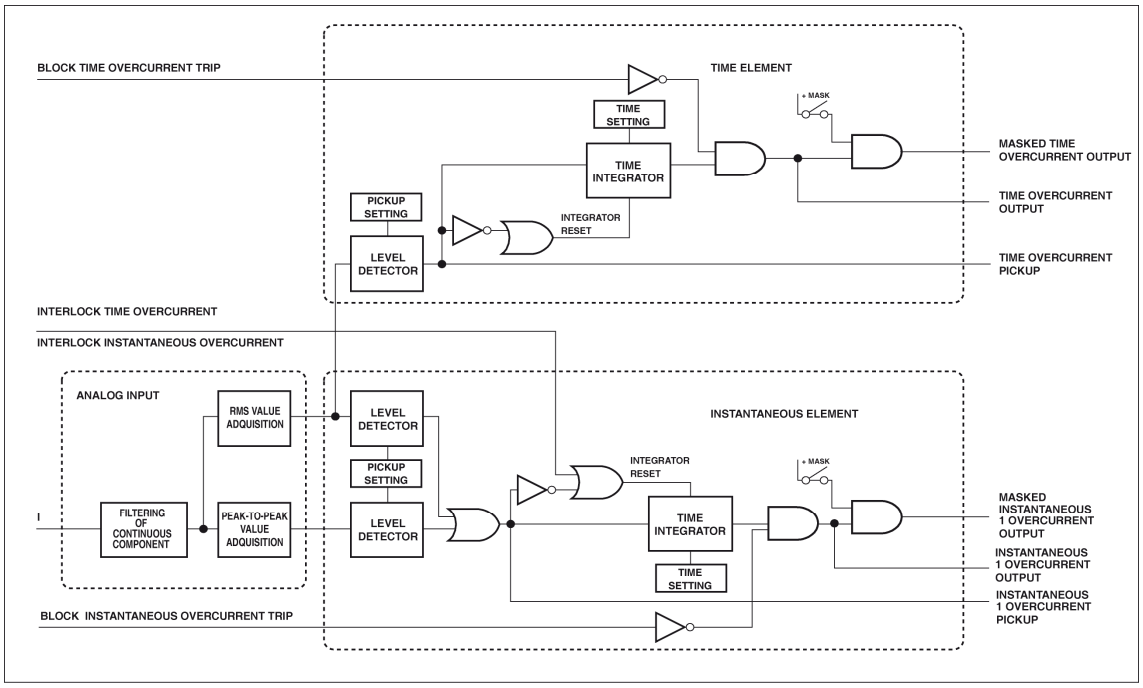

Figure 6.7: Overcurrent Unit Block Diagram (7IVD-K/L Model).

6.1.4 Torque Control (Pickup Lockout Enable)

The **torque control** setting or **pickup lockout enable** has two well-differentiated functions. One is associated with the **directional element (7IVD-L)**, enabling or disabling the directionality of the IED; the other is the **time meter reset** included in the time and instantaneous overcurrent elements.

You can select or deselect the directionality of the various phase and ground instantaneous or time overcurrent elements with this setting in each IED's protection group: an element with **torque control** or **pickup lockout enable** set to **NO** becomes non-directional.

Both the time and instantaneous overcurrent elements have an input called **torque annulment** for both phase and ground. Its job is to reset their time counter. When this signal is activated, the time counters are reset.

For a trip to occur, this input must remain deactivated during the entire timing process (from pickup to trip). For one of the **torque annulment** inputs to work, it must be so configured and the **torque control** or **pickup lockout enable** must be set to **YES**..

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6.1.5 Block Trip and Bypass Time

Both instantaneous and time overcurrent elements can program **block trip** inputs, which prevents the operation of the element if this input is activated before the trip is generated. If it is activated after the trip, it resets. To be able to use these logic input signals, program the status contact inputs defined as **block trip**.

In the **7IVD-L** model, the **block trip** of the ground instantaneous and time overcurrent elements can be enabled at the same time by a **command** sent via the **HMI** or via **communications**. The blocking logic is the following:

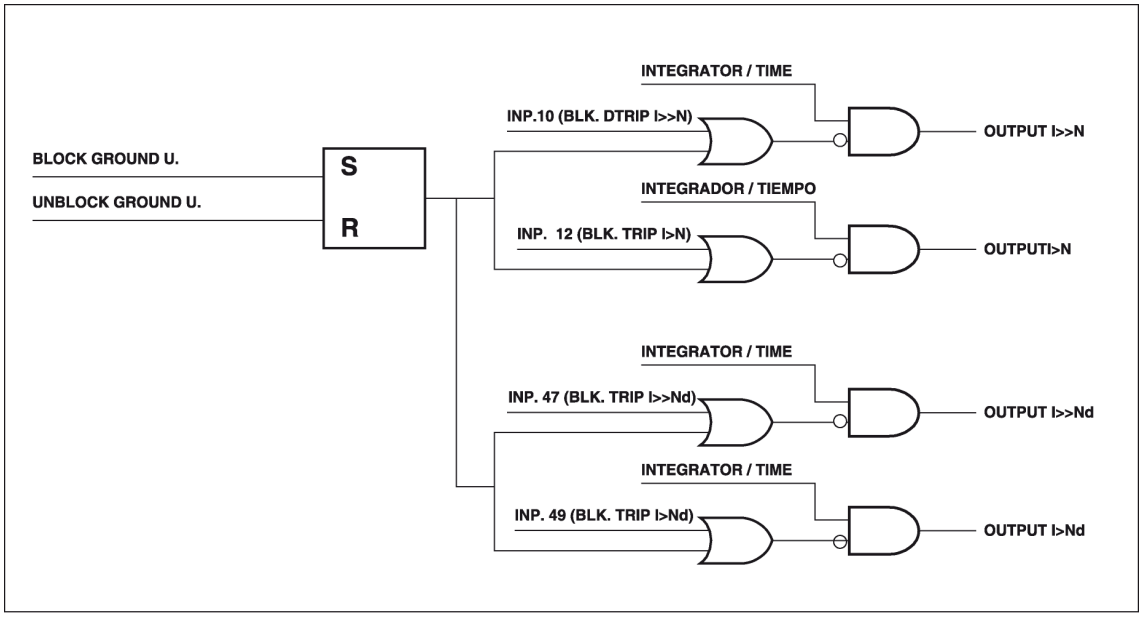

Figure 6.8: Block Trip Logic (7IVD-L Model)

Another programmable input can change a time overcurrent element into an instantaneous element. This input is called **bypass time** and is available for the both phase and ground time elements.

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6.2 Directional Element (Model 7IVD-L)

The mission of the directional element is to determine the direction in which the operating current is flowing in order to control its associated overcurrent element. The direction is determined by comparing its phase with that of a reference value, the phase of which is maintained irrespective of the direction of the flow of the operating current.

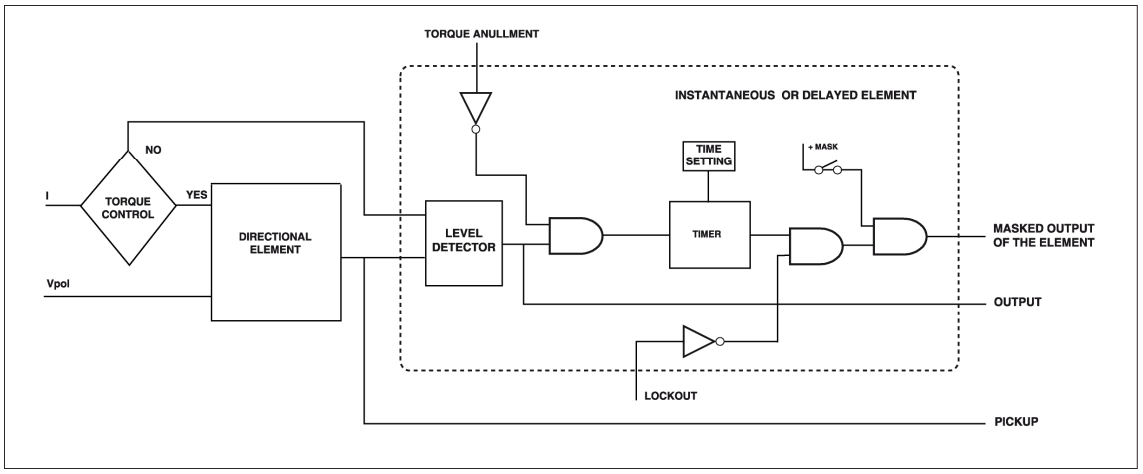

Figure 6.9: Block Diagram of a Directional Overcurrent Element.

The purpose of the directional element is to monitor the overcurrent element whenever the **torque control** setting is **YES** and impede its pickup if the current flows in the opposite direction from the chosen one. That is, it must first see the direction (start the directional element) and then detect a sufficient level to generate the trip. If the directional element inhibits the operation of the overcurrent element, the timing function will not start. If the inhibition occurs once the timing has started, it will reset so that the timing will start again from zero if the inhibition disappears. In any case, a trip requires the timing function to be uninterrupted.

The directional element requires voltage and current thresholds to be able to see the trip direction. These values are **1 V** and **0.02 In** (where **In** is the IED's nominal current). Once these thresholds have been reached, the directional element can start if the conditions exist in the direction of the current flow. If the current has not reached either of the two thresholds once the element has picked up, the directional element will reset.

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6.2.1 Phase Elements

There is a directional element for each of the phases. In any one of them, the operating value is the phase current and the polarization value is the line voltage corresponding to the other two phases.

Table 6-1 shows the operating and polarization values applied to each of the three phases.

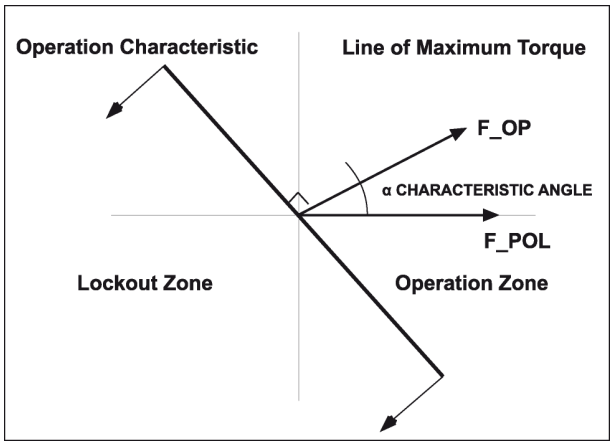

Figure 6.10: Vector Diagram of the Phase Directional Element.

Table 6-1:Operating and polarization value		
Phase	**Operating value (F_OP)**	**Polarization value (F_POL)**
A	IA	UBC = VB - VC
B	IB	UCA = VC - VA
C	IC	UAB = VA - VB

Drawn on a polar plot, the operation characteristic is a straight line the perpendicular of which (line of maximum torque) is rotated a certain angle counter clockwise, called characteristic angle, with respect to the polarization value. This straight line divides the plane into two semiplanes. The directional element enables the overcurrent element when the phasor of the operating value is in the operation zone, 90º with respect to the line of maximum torque, and inhibits it when it is in the opposite semiplane. As already mentioned, directional control is phase by phase.

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6.2.1.a Example

This section will analyze the setting value of the **characteristic angle** for the phases with respect to the **polarization magnitude** that the IED uses to establish the **line of maximum torque**, which gives rise to the **operation** and **blocking** zones of the phase differential elements.

The simplest case is a three-phase line open at one of its ends. Suppose a single-phase fault of phase A to ground and without default impedance. If the impedance of the line is **ZI_α,** current **I_A**, which will circulate through the fault will be generated by the presence of voltage **V_A** and an angle **α** delayed with respect to it.

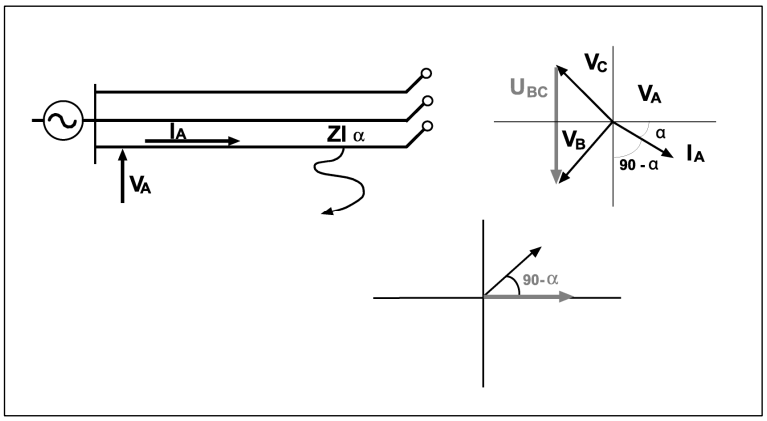

Figure 6.11: Graphics for the Example.

7IVD-L IEDs with directional elements for the phases do not use the simple phase currents as polarization value for each of their corresponding operating values (the currents of each phase). The **polarization values** used are the phase-to-phase voltages between the other two phases not involved in the possible single-phase fault (see table 6-1).

As the graphics above show, for a fault in phase A like the one described initially, the polarization value that the IED uses to decide whether or not there is a trip is voltage $U_{BC} = V_B - V_C$, which is delayed in quadrature with respect to the simple voltage of faulted phase V_A.

Since the **characteristic angle** (α) **set in the IED is the one that is between the operating value** and the **polarization value** (see figure 6.6), the value to be assigned it must be the **angle complementary to the argument of the "impedance of the line"**.

Everything said so far for phase A can be extrapolated directly for phases B and C.

To conclude, if the **impedance of the line** is **ZI_θ** the **characteristic angle** (α) to be set for the phases is:

$$\alpha = 90 - \theta$$

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6.2.2 Ground Element

The operation of the directional ground element is based on the use of zero sequence and ground values. The operating value is zero sequence current using two source signals, either alternating or simultaneous, to obtain the polarization value:

- Zero sequence voltage.
- Ground current.

In this case, there are two operation characteristics, one corresponding to each of the two modes, which, when drawn on a polar plot, are straight lines, each of which divides the plane into two semiplanes. The location of the operating value determines the output of the directional element and its action on the overcurrent element.

6.2.2.a Polarization by Voltage

Figure 6.12 diagrams the elements used to explain how polarization by voltage works.

In this case, the operating principle of a ground directional element is based on the determination of the relative phase between the zero sequence current and the zero sequence voltage. The figure applies the same criteria followed in the description of operation of the phase elements so that the concepts dealt with will be absolutely equivalent.

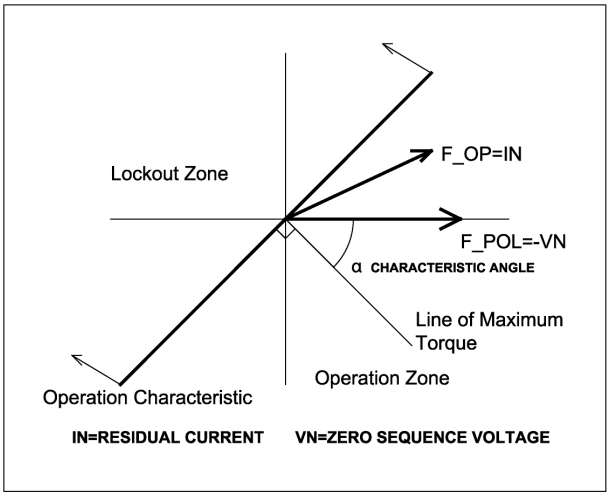

Figure 6.12: Vector Diagram of the Directional Ground Element with Polarization by Voltage.

In order to handle characteristic angles of less than 90º, the opposite phasor of the zero sequence voltage (-VN) has been drawn as polarization value, which rotates the characteristic angle clockwise to obtain the line that divides both areas.

As with the phase elements, the orientation of the characteristic must be such that, in fault conditions, the operating value is between ±90º of the line defined as maximum torque.

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6.2.2.b Polarization by Current

Determining the phase displacement between the residual current and the current circulating through the grounding is simple because the phase displacements between the two magnitudes can only be 0º and 180º or, what is the same, the characteristic angle must always be 0º.

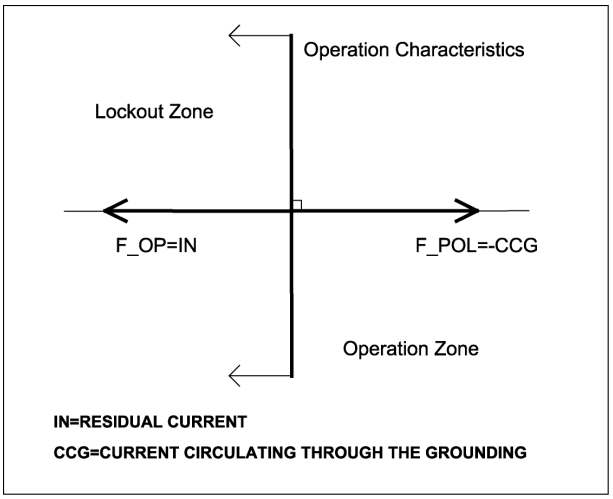

Figure 6.13: Vector Diagram of the Directional Ground Element with Polarization by Current.

The operation zone is the zone in which the fault or operating current In is rotated 180º with respect to the current circulating through the grounding, as in the figure. F_POL is equal to the current circulating through the grounding rotated 180º. Therefore, F_POL and In must be in phase to be in the operation zone.

6.2.2.c Polarization by Voltage and Current

It is common to have both polarizations in the same protection. Therefore, you must define a cooperation criterion to avoid contradictions or uncertainties in the response of the overcurrent elements. The criterion used is generally the following: **operation takes priority over blocking**.

Blocking of the overcurrent element requires both polarization criteria to detect the current in the direction opposite to the trip current. Only one of the two criteria detecting the current in the trip direction is sufficient to permit the overcurrent element to operate.

6.2.3 Blocking Due to Lack of Polarization

The IED has a setting among the **protection** group directional elements that determines the behavior of the directional elements if the polarization values are lost.

If the setting is **YES**, the loss of the polarization voltages will put the output of the directional element into the state of **no trip**. If the value of the setting is **NO**, the loss of polarization will give rise to a permanent trip permission in the directional element, irrespective of the angle relationships between the operation values and polarization.

6.2.4 Inversion of the Trip Direction

The directional element has a logic input that can be connected to one of the digital status contact inputs by means of their programming capacity. Its function is to invert the trip direction. When this input is in its default state, the trip direction is the one indicated in the previous diagrams. If this input is activated, the trip direction inverts.

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6.3 Undervoltage Elements

The IED has three undervoltage elements associated with the voltage analog inputs: **V1**, **V2** and **V3**. It operates when the RMS of the voltages measured falls below a certain value. This value is set simultaneously for the three voltages and their variation interval is specified in Chapter 5.

The elements have an **associated logic** which can be controlled with a setting in which you select between the following two possible types of operation (see figure 6.15):

- **AND**: the element trips when the three undervoltage elements comply with the trip condition.
- **OR**: the element trips when any of the three undervoltage elements complies with the trip condition.

For a given undervoltage element, pickup occurs when the value measured falls to the setting value and resets when it exceeds 1.05 times the setting value. When the RMS exceeds the set pickup, a rapid reset of the integrator occurs. The activation of the output requires the pickup to remain activated throughout the integration. Any reset leads the integrator to its initial conditions so that a new operation initiates the time count from zero.

You can assign an analog input to the logic signal that **blocks the trip signaling of the undervoltage time element**, thus disabling the output if this signal is activated. The blocking signal can be different for each of the undervoltage elements.

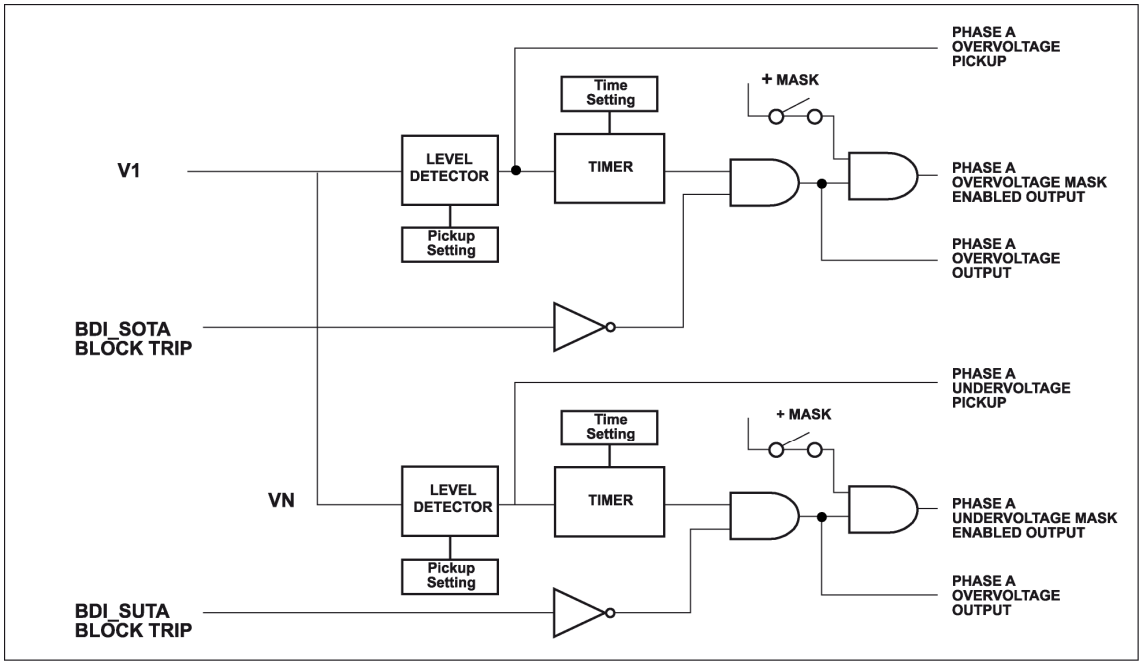

Figure 6.14: Block Diagram of an Overvoltage / Undervoltage Element.

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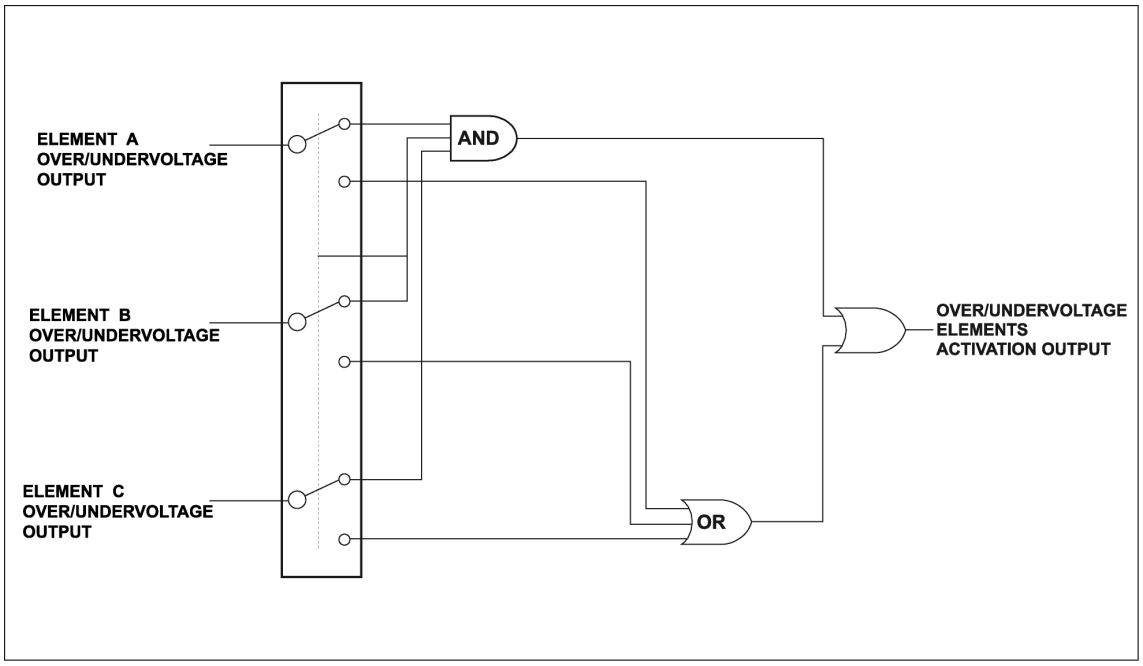

Figure 6.15: Block Diagram of the AND/OR Operation for the Voltage Elements.

6.4 Overvoltage Elements

The IED has three overvoltage elements associated with the voltage analog inputs **V1**, **V2** and **V3**. The overvoltage elements behave the same way as the undervoltage elements (see figure 6.14), including the same trip logic and the same associated logic to determine the type of operation (AND / OR; see figure 6.15).

Each element picks up when the RMS of the voltage surpasses the pickup setting and resets at 0.95 times the pickup setting.

6.5 Frequency Elements

The purpose of the frequency elements is to detect any abnormal frequency level. This requires two elements that can function as **underfrequency or overfrequency elements** in the range of 40 – 70 Hz. These elements are associated with voltage input **Vb**.

The elements are enabled and disabled together by means of a setting or automatically when the measured voltage drops below a minimum level, which can be set as a percentage of the rated voltage in a range of 40% - 100%.

The elements pick up when the set level is reached and reset when the frequency surpasses 100.1% of the setting (minimum) or drops below 99.9% of it. They also reset when the frequency is above the setting (minimum) or below it (maximum) during more than 30 cycles.

Once the frequency level and the element's type of functioning are set, you can adjust the output time delay with a setting in the range of 0.005 s to 20 s independently for each of the elements.

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6.6 Breaker Failure Function

The **Breaker Failure** function detects malfunctions following trip commands and generates a signal to trip other breakers to clear the fault. You can follow the operation of this function on the block diagram of figure 6.16.

A trip command generated by the IED's Internal Protection elements **(TRIP)** or an External Protection Device **(EPD)** activates the **breaker failure initiate** signal **(I_BF)**. When the **I_BF** signal is activated and current is still detected by the IED (**C_IN** signal), the breaker failure signal **(P_BF)** starts the counter for the breaker failure time delay (T_BF). If T_BF times out before **I_BF** resets, indicating that the initial breaker failure conditions are no longer present, or **C_IN** resets, indicating that the IED no longer detects current, the **BF** output will activate.

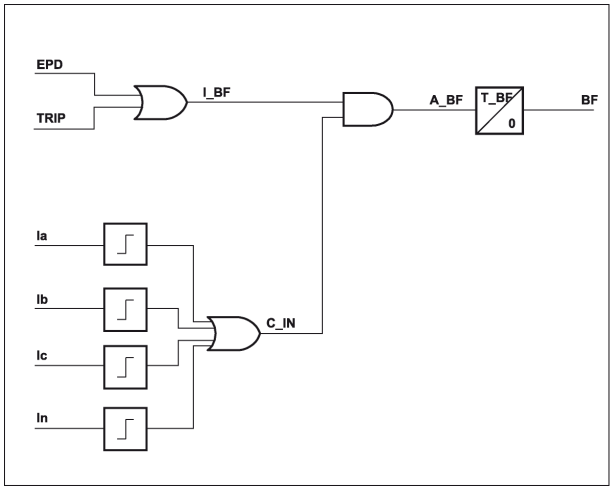

Figure 6.16: Block Diagram of the Breaker Failure Element.

The reset of either of the signals, **I_BF** or **P_INT**, will immediately reset the timer, impeding the generation of the **BF** signal.

The **C_IN** signal indicating the presence of current remains active whenever one or more of the current detectors, **D_IA**, **D_IB**, **D_IC** or **D_IN**, are active. The latter correspond to each of the phase currents and to the ground. The key characteristic of the current detectors is their fast reset time, which stops the timer as soon as the breaker opens and the current has disappeared in order to avoid inadvertent **BF** activation. Longer reset times risk incorrect tripping of breakers outside the protection zone when current is no longer detected.

To be able to use the external operation signal (**EPD**) as part of this function, you must program one of the IED's status contact inputs to be connected to this signal. Otherwise, the **EPD** signal will default to a logic "0". Likewise, the external use of the logic output of breaker failure (**BF**) requires programming the connection between it and one of the auxiliary contact outputs.

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6.7 Open Phase Element

- **Without minimal load in the line setting**

The purpose of the **open phase** element is to detect unbalance of the phases of the protected line. It functions by measuring the inverse sequence content of the circulating current.

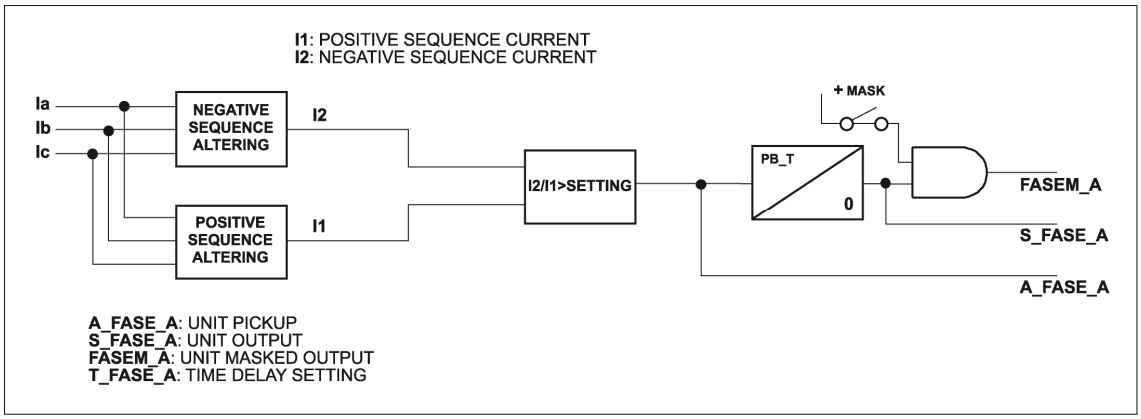

Figure 6.17: Block Diagram of the Open Phase Element (without minimal load in the line setting).

The operation of this function is conditioned to the position of the breaker and to the level of the direct sequence current: if the breaker is open or the direct sequence current is less than 100 mA, the element will be disabled. In addition, the function is annulled when any one of the phase or ground time measuring or instantaneous elements picks up. The disablement of the function does not annul the measurement of the direct and inverse sequence currents, which will continue to appear in the *display* whenever you request them.

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- **With minimal load in the line setting**

In the particular case of some models, you can set the level of direct sequence current necessary for this element to operate. Thus, defining a **minimum load in the line** in the form of direct sequence current, the logic of this element is the following:

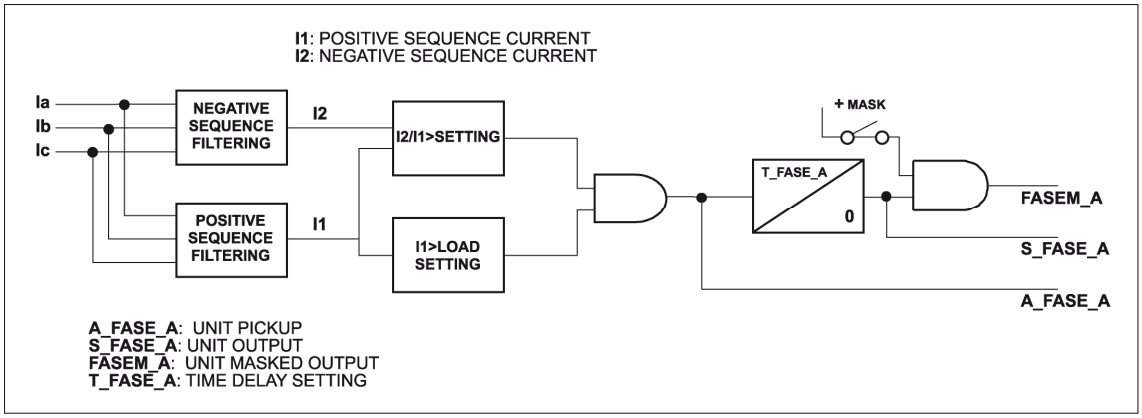

Figure 6.18: Block Diagram of the Open Phase Element (model 7IVD-L) (with minimal load in the line setting).

6.8 Residual Current Detection Element

The **zero sequence** (**residual current**) element is designed to detect, and eventually trip, situations of sustained residual currents or of imbalances with zero sequence current below the value set for detecting ground faults.

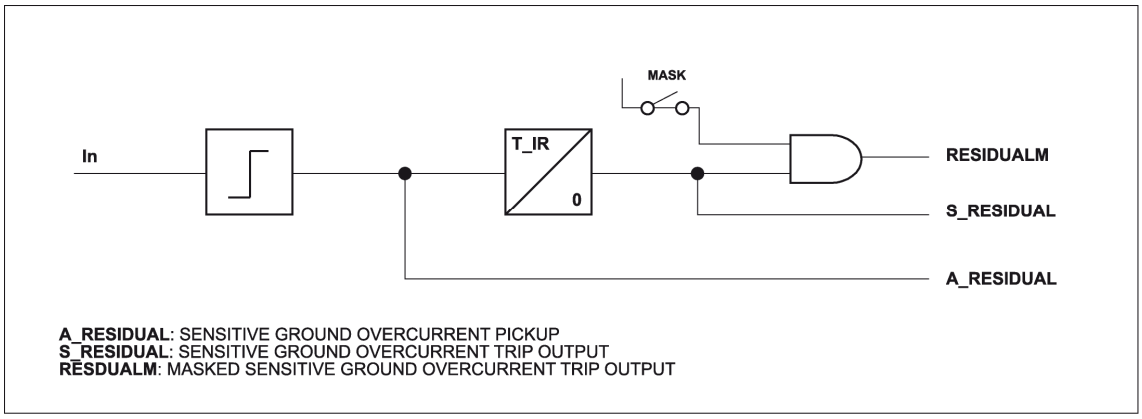

Figure 6.19: Block Diagram of the Residual Current Detection Element

The current to be measured by this function comes from the same input used for detecting ground faults. When this current exceeds the set value, the pickup signal of the element (**A_RESIDUAL**) is activated and, if the pickup conditions are sustained for a time equal to or greater than the set time, the **S_RESIDUAL** trip command will occur. There is a setting that allows the disablement of the residual current detection element. The function is disabled by the pickup of any of the phase or ground elements..

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6.9 General Settings

- **Unit in service**

IED enabled (**YES**) allows every function in the system to be executed (as programmed in the corresponding settings).

IED disabled (**NO**) only leaves the system metering functional. Metering values will be displayed in the HMI and sent via communications.

- **Transformation ratio**

The transformation ratio defines the mode in which the analog values are viewed in the protection display.

If the transformation ratio is set to 1, the display will present secondary values. If, on the contrary, you choose the transformation ratio corresponding to the analog input of the matching transformers, the display will present primary values.

- **Breaker position open**

The **breaker position open** input has the function of controlling the state of the breaker and can be defined as contact generally closed (with breaker open), which corresponds to setting **"1"**, or as contact generally open (with breaker open), which corresponds to setting **"0"**.

The breaker status is used by the recloser to define the **lockout by open breaker** and **reclose sequence initiate** state. Furthermore, it is related to the **maneuvers of the breaker** made from the keypad and via communications. And lastly, the **open phase element** will not pick up if the breaker is open.

- **Event masks**

It is possible to mask any unneeded or unused events for system behavior analysis. This feature is only available via the ZIVercom® communications software.

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6.10 Configuration Settings (7IVD-L model)

- **Phase sequence**

The system's phase sequence (ABC or CBA) can be selected to adapt the relay's measurement in each case to the configuration of the network. This setting often eliminates the need to install phase transducers to adapt standard substation projects to electricity systems with a variable phase sequence on the grid. This is how it works:

- When the phase sequence on the grid is ABC, the connections between the IEDs and the grid are coherent:

Grid		Transformer		Equipment (relays,...)
Phase A (conductor 1)	→	H1-h1	→	Phase A
Phase B (conductor 2)	→	H2-h2	→	Phase B
Phase C (conductor 3)	→	H3-h3	→	Phase C

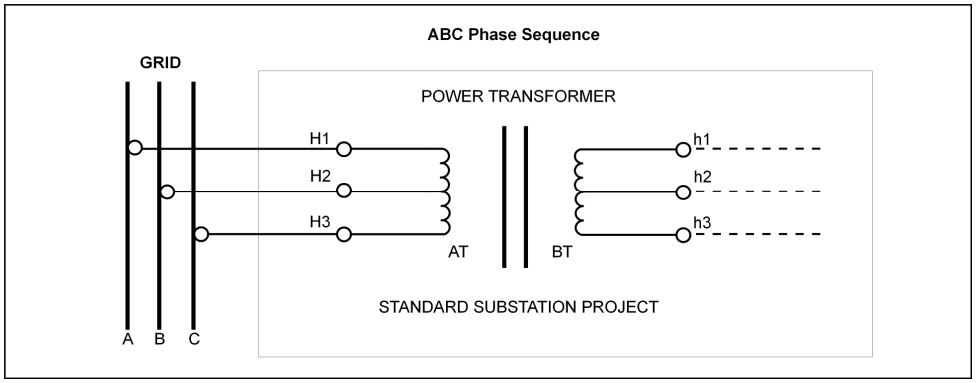

Figure 6.20: Phase Sequence ABC (Model 7IVD-L)

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- When the phase sequence on the grid is CBA, the connections are the following:

Grid		Transformer		Equipment (relays,...)
Phase C (conductor 1)	→	H1-h1	→	Phase A
Phase B (conductor 2)	→	H2-h2	→	Phase B
Phase A (conductor 3)	→	H3-h3	→	Phase C

Therefore, the IED must be able to interpret, for measurement and protection, that the value read by the channel connected to *conductor 1* is actually *phase C* of the system. The same happens with the channel connected to *conductor 3* and *Phase A* of the system.

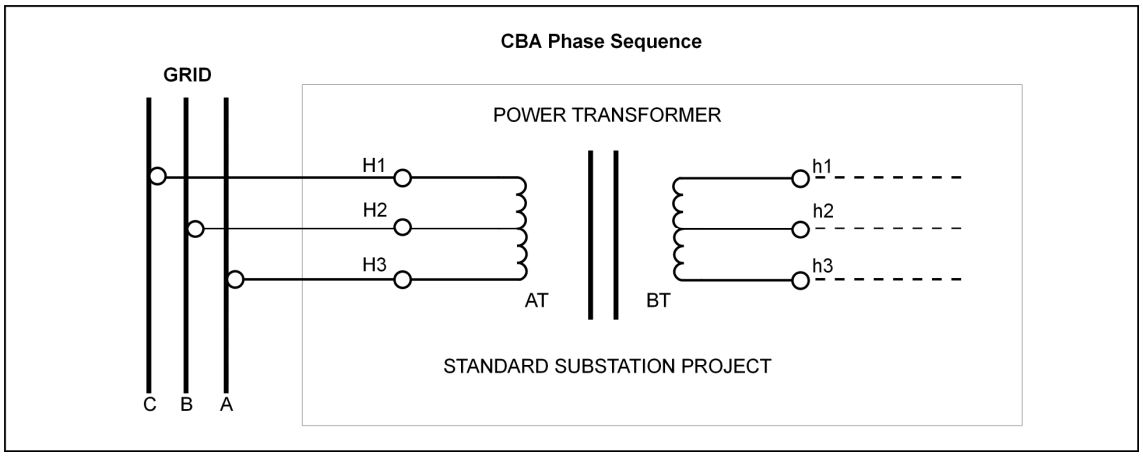

Figure 6.21: Phase sequence CBA (Model 7IVD-L).

All the foregoing is applicable to currents as well as voltages.

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6.11 Recloser

The model **7IVD** recloser function is designed to initiate up to four reclose attempts with independent settings for the reclosing times of each.

The recloser can be set to respond with different reclosing and safety times after a reclosing depending on whether it is an interphase fault or some ground element is involved.

The types of reclosings controlled are:

- Initiation of reclosing for ground faults tripped by the time elements (ground timer)
- Initiation of reclosing for interphase faults tripped by the time elements (delayed phase).
- Initiation of reclosing for ground faults tripped by the instantaneous elements (ground instantaneous).
- Initiation of reclosing for interphase faults tripped by the instantaneous elements (phase instantaneous).
- Initiation of reclosing by trip of the open phase element.
- Initiation of reclosing by trip of the residual current or zero sequence element.
- Initiation of reclosing by operation of the external protection.

Figures 6.22 and 6.23 display the flow charts that describe how the recloser works. The **RI** signal (Reclose Initiate) is the logical sum of the following two signals:

IR-F (Reclose initiate for interphase faults)
IR-N (Reclose initiate for ground faults)

That is: **RI = RI-P + RI-N**

RI is activated when either **RI-P** or **RI-N** is activated and is reset when both are reset.

6.11.1 Reclose Sequence

Up to four reclose attempts can be programmed in the reclose sequence. A series of operations is performed in each of these sequences, which is controlled by the recloser settings and by certain external events detected through the system of digital status contact inputs or received from the protection elements within the **7IVD** IED itself.

- **Sequence Start**

When the recloser function is in the recloser reset state, reclosing is initiated when there is a trip by any of the enabled protection elements or when the digital input of the operation of an **External Protection Device** (**EPD**) is activated. In either case, the **RI** (**Reclose Initiate**) signal will activate and the recloser will switch from its **Reset** state to its **Sequence Check Time** state. The sequence check time counter begins timing at this point. If this times out before the fault is cleared (**RI** deactivated) and the breaker opens (**CB**), the recloser switches to **Recloser Lockout due to Breaker Failure**. The only way out of this state is with a close command to the breaker. Otherwise, the sequence will begin with the activation of the **RSP** (**Reclose Sequence in Progress**) signal.

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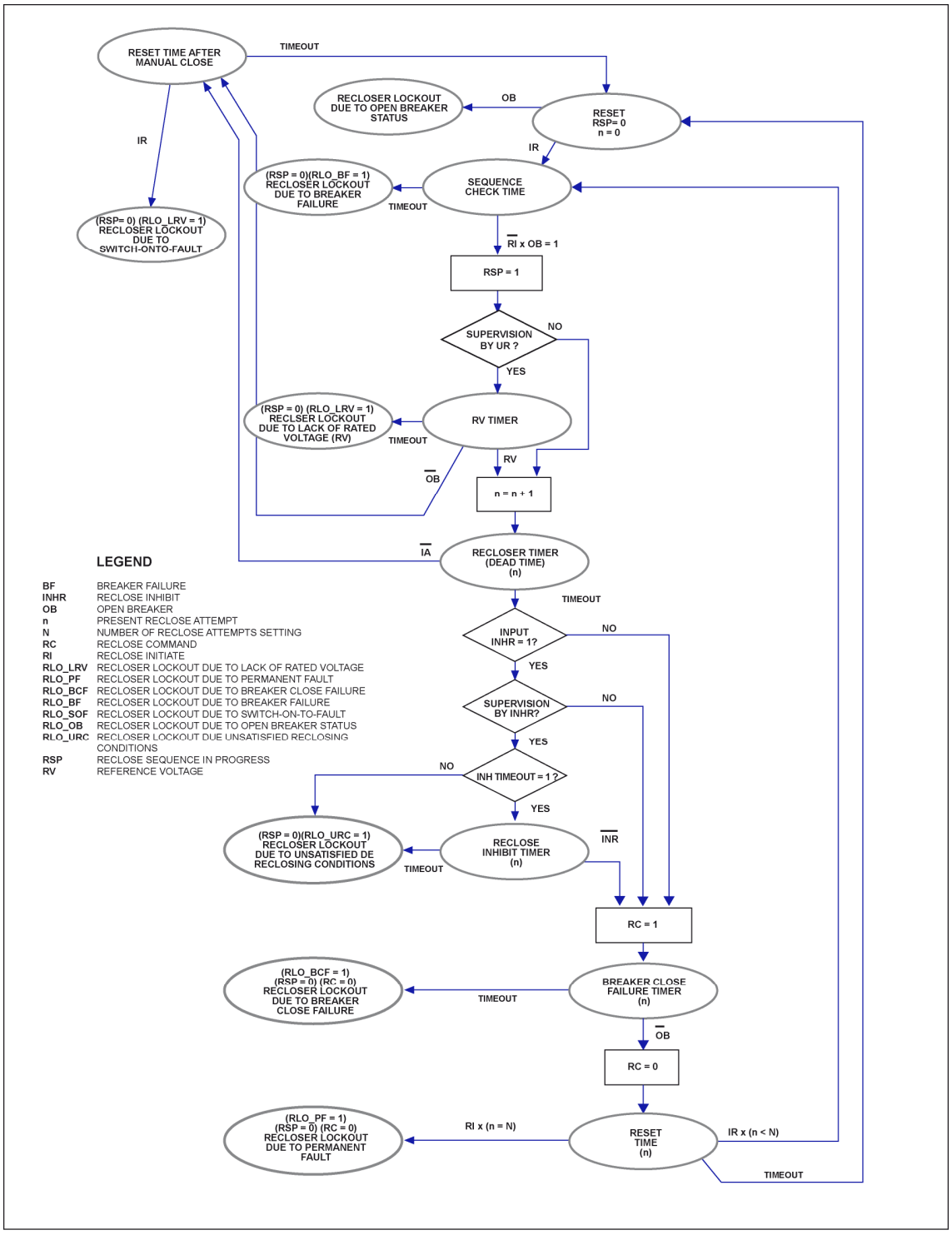
RESET TIME AFTER MANUAL CLOSE
TIMEOUT
RECLOSER LOCKOUT DUE TO OPEN BREAKER STATUS
OB
RESET RSP= 0 n = 0
IR
IR
(RSP = 0)(RLO_BF = 1) RECLOSER LOCKOUT DUE TO BREAKER FAILURE
SEQUENCE CHECK TIME
TIMEOUT
(RSP= 0) (RLO_LRV = 1) RECLOSER LOCKOUT DUE TO SWITCH-ONTO-FAULT
RI x OB = 1
RSP = 1
SUPERVISION BY UR ?
NO
YES
(RSP = 0) (RLO_LRV = 1) RECLSER LOCKOUT DUE TO LACK OF RATED VOLTAGE (RV)
RV TIMER
TIMEOUT
RV
OB
n = n + 1
IA
RECLOSER TIMER (DEAD TIME) (n)
TIMEOUT
INPUT INHR = 1?
NO
YES
SUPERVISION BY INHR?
NO
YES
NO
INH TIMEOUT = 1 ?
YES
(RSP = 0)(RLO_URC = 1) RECLOSER LOCKOUT DUE TO UNSATISFIED DE RECLOSING CONDITIONS
TIMEOUT
RECLOSE INHIBIT TIMER (n)
INR
RC = 1
(RLO_BCF = 1) (RSP = 0) (RC = 0) RECLOSER LOCKOUT DUE TO BREAKER CLOSE FAILURE
TIMEOUT
BREAKER CLOSE FAILURE TIMER (n)
OB
RC = 0
(RLO_PF = 1) (RSP = 0) (RC = 0) RECLOSER LOCKOUT DUE TO PERMANENT FAULT
RI x (n = N)
RESET TIME (n)
IR x (n < N)
TIMEOUT
LEGEND
BF BREAKER FAILURE
INHR RECLOSE INHIBIT
OB OPEN BREAKER
n PRESENT RECLOSE ATTEMPT
N NUMBER OF RECLOSE ATTEMPTS SETTING
RC RECLOSE COMMAND
RI RECLOSE INITIATE
RLO_LRV RECLOSER LOCKOUT DUE TO LACK OF RATED VOLTAGE
RLO_PF RECLOSER LOCKOUT DUE TO PERMANENT FAULT
RLO_BCF RECLOSER LOCKOUT DUE TO BREAKER CLOSE FAILURE
RLO_BF RECLOSER LOCKOUT DUE TO BREAKER FAILURE
RLO_SOF RECLOSER LOCKOUT DUE TO SWITCH-ON-TO-FAULT
RLO_OB RECLOSER LOCKOUT DUE TO OPEN BREAKER STATUS
RLO_URC RECLOSER LOCKOUT DUE UNSATISFIED RECLOSING CONDITIONS
RSP RECLOSE SEQUENCE IN PROGRESS
RV REFERENCE VOLTAGE

Figure 6.22: Recloser Flow Diagram (I).

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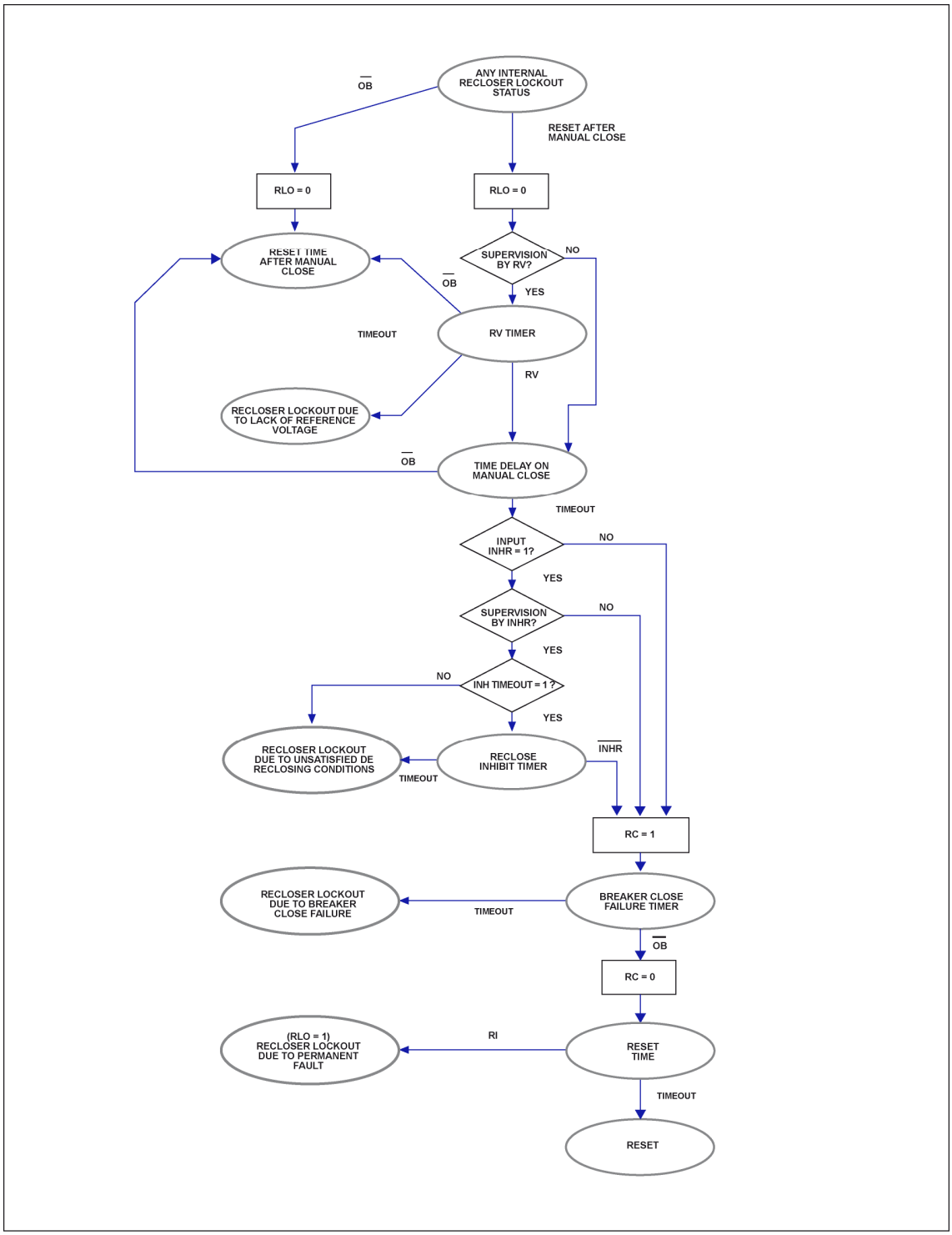

Figure 6.23: Recloser Flow Diagram (II).

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- **Reclose Supervision by Rated Voltage**

When the sequence has left the **sequence check time** state and if the **reclose supervision by rated voltage** setting is **YES**, the next step in the reclose logic process is a **Rated Voltage Timer** (RV Timer). In this state, it monitors the activation of the **RV** input during the user-defined time interval. If this voltage is detected within the mentioned time, the recloser switches to the **reclose timer (dead time)** state prior to the first reclose attempt. If it times out before the rated voltage is detected, the recloser switches to the **recloser lockout due to lack of rated voltage** state.

If the **monitoring of reclosings by reference voltage** setting is **NO**, the **reclosing time** state will be reached without going through the **awaiting reference voltage** state.

- **Recloser Time (Dead Time)**

Upon switching to this state, the **recloser time** will start counting. It is different for each close attempt. When this timer has timed out, the activity of the **INHR** (Reclose Inhibit) input status is verified.

If there is no INHR signal, the **RC** (Reclose Command) is activated and the **closing time** state is achieved. If there is an INHR signal, the **supervision by reclose inhibit** setting status is checked: if the setting is **NO**, **RC** (reclose command) activates and the **closing time** state is achieved. If the value is **YES**, the **timer** setting is checked. If this setting is **YES**, the recloser **reclose inhibit timer** starts and monitors the **INHR** input reset during the period of time set. If the **timer** setting is **NO**, indicating no need to wait for this reset, the state changes to **recloser lockout due to unsatisfied reclosing conditions**.

- **Closing Time**

Upon switching to this state, an adjustable **breaker close failure timer** is started and the **RC** output activates to send a close command to the breaker. If the breaker closes before the breaker close failure time runs out, the recloser **reset time** state is achieved. If the time runs out without the breaker closing, the recloser state switches to **recloser lockout due to breaker close failure**. In either case the **Recolose Command (RC)** output deactivates.

- **Reset Time**

When this state is achieved, an adjustable **reset timer** is started. The reset time setting corresponds to the closing attempt that the recloser is currently executing. This timing serves to discriminate whether two consecutive trips correspond to the same fault and have not been successfully cleared or if they actually correspond to two consecutive faults. If the **reset time** runs out without a trip occurring, the recloser switches to the **recloser reset** state and the reclose attempt is completed successfully.

If there is a trip (**RI** activates) before the **reset timer** times out, the next step depends on whether or not the number of reclose attempts setting has been reached. If that limit has been reached, the recloser switches to the **recloser lockout due to permanent fault** state and the reclose sequence ends. Otherwise, the new trip initiates a new reclose sequence and the recloser switches to the **sequence check time** state.

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6.11.2 Recloser Lockout

The **internal blocking** states correspond to situations in which the recloser will not initiate its cycle when there is a trip and, therefore, all the trips that occur in such circumstances will be **definitive**.

The preceding section defined the recloser lockout states to which the recloser can arrive once it has abandoned the **recloser reset** state because of a fault and its corresponding trip. Nevertheless, there is another circumstance that can produce **recloser lockout**: the opening of the breaker without a fault associated with the breaker operation. In this circumstance, the recloser switches to the **recloser lockout due to open breaker** state and reclosing is disabled.

The recloser will remain in any of the recloser lockout states until a closed breaker is detected or the IED initiates a close command.

6.11.3 Manual Close

There are two **manual close** operations that affect the status of the recloser:

- **External manual close**

This situation arises when the recloser detects that the breaker has closed by way of the open breaker status contact input without the command originating from either the recloser or the **7IVD** command system.

When this condition is detected, the recloser leaves the **recloser lockout *state*** and switches to the **reset time after manual close** state**.** Upon entering this state, the timer for the **reset time after manual close** starts**.** If it times out without a trip occurring, the recloser switches to the **recloser reset** state. If there is a trip before it times out, the recloser switches to the **internal blocking by closure due to a fault or to energizing the line** and the trip is **definitive**, without subsequent reclosing.

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- **Recloser manual close**

This situation arises when the **7IVD** command function sends a close command to the recloser. For this to happen, you must set the **recloser manual close enable** to **YES** (this setting belongs to the **logic** settings group). A close command of this type starts up a mechanism that is exactly like the last programmed reclose attempt except that there is no sequence check time and different values are used in the following settings:

- **Manual close supervision by rated voltage** (reclose supervision by rated voltage).
- **Manual close supervision by reclose inhibit**.
- **Waiting time to deactivate inhibition input**.
- **Manual close time** (equivalent to reclosing time).
- **Reset time after manual close**.

After completing the same process as in the last closing attempt, the **Reset time after manual close** starts counting and ends in **recloser lockout** if a trip occurs before it times out. Otherwise the recloser returns to the **recloser reset** state.

6.11.4 Manual and External Blocking

Of the two blockings for the recloser, manual and external, the **blocking commands** received first take preference. The only way out of this blocking situation is with a contrary command.

- **Block reclosing**

A command through the **human-machine interface (HMI)** or via communications (in local or remote mode) can switch the recloser to **lockout** state. If the recloser is in a reclose sequence, it will stop when it receives this block reclosing command. In this state, it will initiate no reclose attempt after a trip, meaning that it will be definitive in all cases.

Exiting the **blocked** status requires a recloser unblock command through the **human-machine interface (HMI)** or via communications (local or remote). If the breaker is open upon receiving this command, the recloser changes to the **recloser lockout** state, from which it exits when the breaker closes. If the breaker is closed, the **Reset after manual close** timer is started and eventually the recloser reaches the **recloser reset** state.

- **Recloser external lockout**

The **recloser external lockout** operates the same as **block reclosing** except that the recloser unblock command and the block reclosing command are received through a status contact input. If this input is activated, the recloser will become blocked and will exit this state when that input is deactivated.

Depending on the model, the **recloser external lockout** and **external unblocking** commands correspond to the **activated / deactivated** states of a single status contact input (blocking by level) or to the reception of blocking / unblocking pulses through two different status contact inputs (blocking by pulses).

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6.11.5 Definitive Trip

The recloser function will generate a **definitive trip (DT)** signal if the fault persists when the reclosing sequence finishes.

You can also configure an auxiliary output **(DT+TRIP*BLQ)**—also taken as a definitive trip so that, in addition to the actual definitive trip, the recloser will switch to the **recloser lockout** state when a trip occurs with the recloser blocked manually or externally.

When a trip occurs with the recloser function blocked, either from the **HMI** or from the corresponding status contact input, the definitive trip command **(DD+TRIP*BLQ**) persists until the element that generated the trip resets. In general, the IED acts this way whenever there is a trip that is not going to be followed by a reclosure.

6.11.6 Recloser Not in Service

The recloser function is placed in the **not in service** state whenever the **recloser in service** setting is disabled**.** With this option selected, the recloser function is completely disabled and the trip masks of the protection elements are not operative.

6.11.7 Reclose Attempts Counter

There are two counters accessible from the operator interface *display* that indicate the number of reclose attempts made since the last reset. You can perform this action from the **HMI**. The first records the number of first reclose attempts, and the second counts the remaining reclose attempts. For example, where the number of reclose attempts is set to four and a fault has been successfully cleared after the fourth trip, the first counter is incremented one count and the second counter in three counts.

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6.11.8 Recloser Control Masks

The following settings control what trips will be allowed and what reclose attempts will be initiated, depending on the state that the recloser function is in.

- **Trip permissions**

7IVD-J Model	
Phase instantaneous overcurrent 1	Frequency elements 1 and 2 (*)
Phase time overcurrent	Phase instantaneous overcurrent 2
Ground instantaneous overcurrent 1	Ground instantaneous overcurrent 2
Ground time overcurrent	Open phase unit
Overvoltage element (*)	Residual current unit
Undervoltage element (*)	

7IVD-K Model	
Phase instantaneous overcurrent 1	Overvoltage element (*)
Phase time overcurrent	Frequency elements 1 and 2 (*)
Ground instantaneous overcurrent 1	Open phase unit
Ground time overcurrent	Residual current unit

7IVD-L Model	
Phase instantaneous overcurrent 1	Overvoltage element (*)
Phase time overcurrent	Undervoltage element (*)
Ground instantaneous overcurrent 1	Frequency elements 1 and 2 (*)
Ground time overcurrent	Undervoltage element (*)
Directional phase instantaneous overcurrent	Frequency elements 1 and 2 (*)
Directional phase time overcurrent	Open phase unit
Directional ground instantaneous overcurrent	Residual current unit
Directional ground time overcurrent	

(*) A trip by any of these elements never initiates the reclose sequence.

The enabling and disabling of these elements to generate trip are subordinated to the following **recloser states**:

Recloser reset
Recloser function counting the reset time after close attempt #1, 2, 3 or 4
Recloser function counting the reset time after an external manual close
Recloser function counting the reset time after a recloser manual close

The action of the trip masks is subordinated to the enabling of the relevant element within its own protection settings because, if the element is disabled, it will not pick up. The trip mask corresponding to the **NO** setting prevents the enabling of the trip output signal and/or of the output configured as mask, but the element executes the whole process from its pickup up to the decision to generate a trip. The output signal configured to enable the output of the element is also activated.

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- **Reclosing permissions**

You can enable or disable the **reclosure** for the following faults:

- Ground faults tripped by the ground time overcurrent elements.
- Ground faults tripped by the directional ground time overcurrent elements (7IVD-L).
- Interphase faults tripped by the phase time overcurrent elements.
- Interphase faults tripped by directional phase time overcurrent elements (7IVD-L).
- Ground faults tripped by the ground instantaneous overcurrent elements.
- Ground faults tripped by the directional ground instantaneous overcurrent elements (7IVD-L).
- Interphase faults tripped by the phase instantaneous overcurrent elements.
- Interphase faults tripped by the directional phase instantaneous overcurrent elements (7IVD-L).
- By open phase element trip.
- By residual current detection element trip.
- By the operation of an external protection device.

In model **7IVD-J**, the operational instantaneous elements in this function are phase and ground elements 1. **The operation of instantaneous phase and ground elements 2 does not generate the reclose initiate signal**.

The **recloser states** for which these masks are defined are:

- Recloser function after a trip after recloser reset.
- Recloser function after a trip while in close attempt #1, 2, 3 or 4.

If the recloser function is **out of service** or **blocked**, the masks are not operational and, by default, all the trips become active.

Important: since each setting is independent of the rest, make sure that some unmasked measuring element exists. Otherwise, the protection will be disabled for tripping. Unmasked is YES in the setting (check box selected).

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6.12 Logic

The **logic** group provides the following functions: **trip output seal-in enable**, **timer for breaker open and close failure**, **close through the recloser function** and **coordination time (model 7IVD-L)**.

6.12.1 Trip Output Seal-in Enable

You enable the **trip output seal-in** function by setting the **seal-in** value to **YES**. In these circumstances, once a trip and the subsequent breaker operation command are generated, the command is maintained until the breaker opens, which is detected through its auxiliary contact output wired to the analog input configured as the breaker position.

If you set the **seal-in** value to **NO**, the trip command resets when the protection measuring elements reset. If the breaker associated with the protection fails and the fault is cleared by an upstream breaker, the trip output contact will be destroyed attempting to interrupt the breaker trip coil current.

6.12.2 Breaker Open and Close Failure Timer

The IED is designed to confirm that the breaker has changed state. A breaker open and a breaker close failure time can be programmed for trip and close operations. **Open command failure** *or* **close command failure** alarms are generated if the breaker response is too slow.

The IED will maintain the open or close command if the maneuver is not executed before it times out.

6.12.3 Close through the Recloser Function

As already mentioned in section 6.9.3, the logic of the recloser function can handle close maneuvers if you set the close through the recloser function to **YES**.

6.12.3.a Coordination Time (Model 7IVD-L)

You can use protection IEDs of the **7IVD-L** type for **permissive underreach** by connecting the auxiliary contact of the pickup of the time elements to the enabling input of the carrier device at one end and the *carrier* received contact to an annulment input of the time element in the remote end device.

Consider the case of two parallel lines. The detection of a fault and its subsequent sequential trip in one of them can cause the current in one of the devices of the line in parallel to invert, picked up by the effect of the fault. In this case, the directional element will invert its state and will switch from not permitting to permitting the trip. If the **permissive underreach** annuls the timer, an instantaneous trip will occur because the reset time of the carrier signal is other than zero. To avoid this possibility, there is a **coordination timer** in the **logic** group. It delays the application of the directional permission until the carrier signal has disappeared.

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6.13 Trip and Close Coil Circuit Supervision

This function permits an alarm when an anomalous situation occurs in the breaker's switching circuits: losses of the auxiliary switching power supply voltage or openings in the open and close circuits themselves. Both breaker positions are monitored: open and closed. The monitor function generates two outputs: **trip circuit failure** (**TCF**) and **close circuit failure** (**CCF**), which can be used by the programmable output function to activate any of the IED's auxiliary contact outputs.

Both supervisions, open circuit and close circuit, are handled separately as two independent functions that can be independently set to disabled by means of a setting. Figure 6.24 is the block diagram applicable in the situation of an open breaker.

6.13.1 Open Circuit

In the conditions of figure 6.24 (breaker open), input IN-5 is energized through internal resistor R3. Input IN-6 is not energized because the voltage at terminal B17 is less than its pickup due to the fact that the resistance of R1 is much larger than that of the trip coil. In this situation, the open coil monitoring signal with the breaker closed (**SSP-1**) is active and the open coil monitoring signal with the breaker open (**SBAIA**) is inactive, with the result that the trip circuit failure (**TCF**) output is inactive.

If the trip coil opens, the input that was deactivated, **SBAIA or SSP-1**, activates and sends the trip circuit failure (**TCF**) signal 5 seconds later.

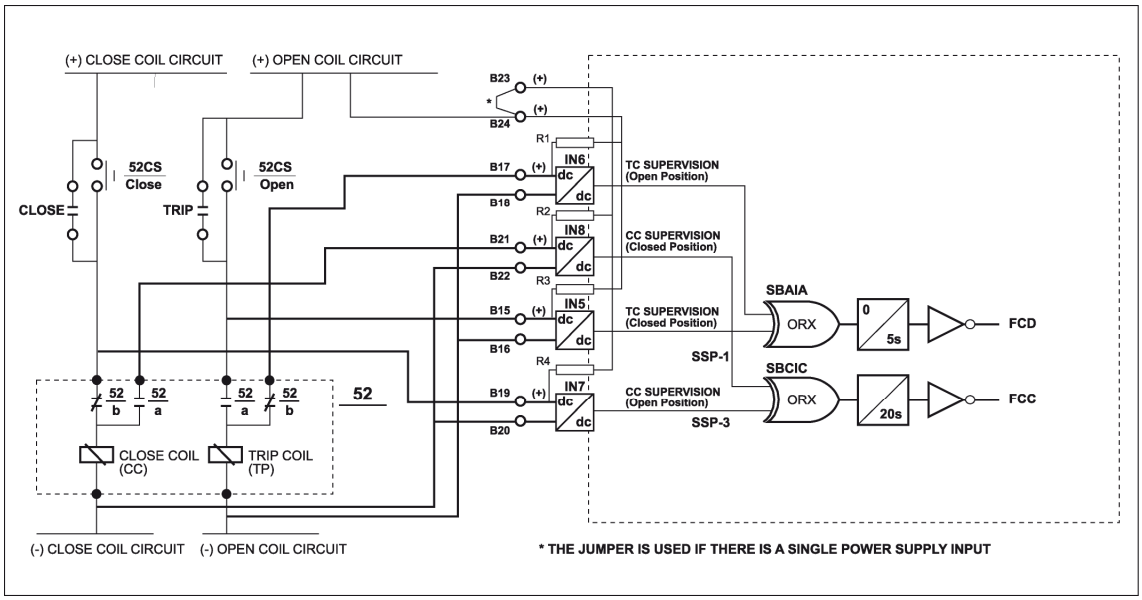

Figure 6.24: Block Diagram and Application of the Monitoring Functions of Switching Circuits.

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If a close or a reclosure occurs while the switching circuit is intact, once the command is executed, the state of the breaker and that of its 52/a and 52/b contacts changes. Consequently, the activation or deactivation of inputs IN-6 and IN-5 will invert, as well as the **SSP-1** and **SBAIA** signals and the **TCF** output will remain deactivated.

The purpose of the 5-second time delay is to compensate for the time gap between the closing of contact 52/a and the opening of 52/b. Generally, **SSP-1** and **SBAIA** signals do not change state simultaneously and, therefore, there will be a discordance between the two contacts. This will not modify the state of the **TCF** output as long as its duration is less than 5 seconds.

If a trip occurs with the breaker closed and the breaker opens, inverting the state of contacts 52/a and 52/b, the **TCF** signal will not activate regardless of the duration of the trip command. If the breaker does not execute the command and the open command persists more than 5 seconds, the **TCF** signal will activate.

If the switching voltage disappears, the inputs that are energized will de-energize and this will activate both switching circuit failure outputs (**TCF** and **CCF**).

When the monitor function of the trip coil detects an open circuit and, consequently, the inability to initiate a trip, this disables the sending of close commands to the breaker through the IED, either manually or from the recloser function.

6.13.2 Close Circuit

The explanation of the open circuit is valid for the close circuit. Just replace references to the open coil with close coil and to open circuit with close circuit. Also change the open commands to close commands. Also remember that the reset time is 20 seconds instead of the 5 seconds indicated for the open circuit. The failure signal in the switching circuit is called **CCF**.

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6.13.3 Selection of the Operation Mode of the Digital Status Contact Inputs

The characteristics of the digital status contact inputs (IN-6, IN-8, IN-5, IN-7) used by the monitoring functions of the switching coils are different from those of the standard status contact inputs. These characteristics are selected through the four jumpers located on the protection board and called **J2**, **J5**, **J1** and **J6**. They are associated with inputs IN-6, IN-8, IN-5 and IN-7 respectively. If the IED has an expansion board, the jumpers will be on the board that contains the power supply. Adapt the inputs to the monitoring functions by placing the jumpers in the **SUP** position.

Associate the monitoring functions to the status contact inputs by means of the programmable inputs function. Assign the correspondence between IN-6, IN-8, IN-5, IN-7 and the signals **SBAIA**, **SBCIC**, **SSP-1**, **SSP-3**. In figure 6.24, the inputs are assigned thus:

IN-6→SBAIA	IN-8→SBCIC	IN-5→SSP-1	IN-7→SSP-3

The monitoring functions have separate enable settings. If one or both are enabled, the unused digital status contact inputs can be used for other purposes as long as you modify the position of the corresponding jumpers.

6.13.4 Trip/Close Output Supervision

Associated with the monitoring functions of the switching coils are the **trip/close output supervision** functions:

Trip coil circuit supervision → Trip signaling failure
Close coil circuit supervision → Close output failure

The latter activate and deactivate together with the former. See their block diagram in figure 6.25.

The **TOF-P1** signal is energized, indicating that the trip signaling has failed to execute an open or trip command if, 50 ms after the generation of the **open** signal, **CSP-1** has not been activated, indicating that the trip contact has closed.

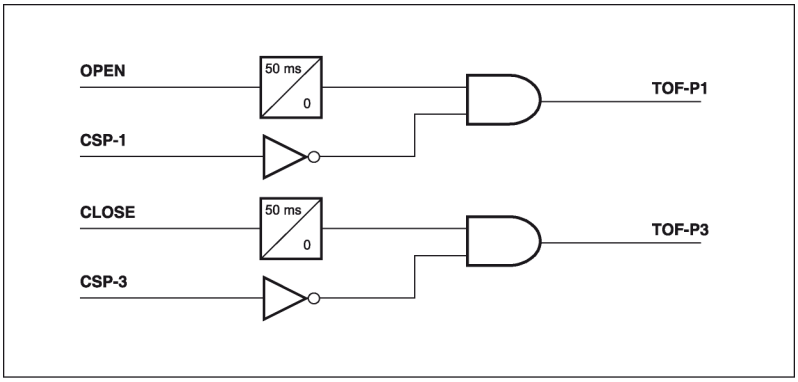

Figure 6.25: Block Diagram of the Monitoring Functions of Switching Outputs.

The **COF-P3** signal is energized, indicating that the close output signaling has failed to execute a close or reclose command if, 50 ms after the generation of the **close** signal, **CSP-3** has not been activated, indicating that the close contact has closed.

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6.14 Breaker Monitoring

To have suitable information for performing maintenance operations on the breaker, the **7IVD** IED records the interrupting current for each trip of the associated breaker and accumulates it as amperes squared. This number is proportional to the accumulated power actually interrupted by the breaker.

When a trip is initiated, it accumulates the square of the largest phase current measured between the trip command and the opening of the breaker, multiplied by the transformation ratio. When the breaker is opened manually, either through the IED or by external means, the value accumulated is equivalent to the square of the phase time delay element setting.

Once the value established for the alarm level is reached, the function activates an alarm signal that can be used by the programmable output function to activate an auxiliary contact output. When activated, the events recorder stores this output.

This function is controlled and consulted by means of two settings:

- **Alarm value of accumulated amperes squared.**
- **Cumulative present value of amperes squared.**

The **Cumulative Present Value of Amperes Squared** is updated by protection whenever a trip or opening operation of the breaker is initiated, and can be modified manually. In the latter case, it represents the baseline value of accumulation to which successive interruption values are added. Manual modification allows you to set an initial value corresponding to the breaker's interruption log upon installation of the IED and to reset it to zero after a maintenance operation.

6.14.1 Excessive Number of Trips

The excessive number of trips function is intended to interrupt an uncontrolled sequence of openings and closings that could damage the breaker. When a certain number of trips is reached, adjustable between 1 and 40, in a given time period (30 minutes), an output signal is generated and it can be connected to any of the IED's physical auxiliary contact outputs.

The activation of the **excessive number of trips** output function disables any further reclose initiation by placing the recloser function in the state of **recloser lockout due to open breaker status**. This condition will reset only after a manual close command or a loss of auxiliary supply.

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6.15 Setting Group Control

The **Protection**, **Reclosing** and **Logic** settings are stored in three groups (Group 1, Group 2, or Group 3). You can activate or deactivate them from the keypad or communications ports, or by using status contact inputs.

This function permits you to modify the active setting groups and, thereby, the response of the protection. This way you can adapt the behavior of the IED to changes in the external circumstances.

You change the setting group through the HMI, which will be explained in Chapter 8, Alphanumeric keyboard and display. You make this change through local communications by means of the setting **Activate setting group** (**Settings** menu).

To use the group change function through the remote port or by status contact input, you must specifically enable it by means of the **settings** menu (submenu **Operation enable** - **Remote setting**) of the HMI. Note that both permissions can not be enabled at the same time.

When Settings Group Control by Status Contact Inputs (**D_SGC**) is enabled, no setting changes can be made from the keypad or from communications. If the active group option on the main menu is selected from the keypad, the display will indicate **access denied**.

The use of this function requires that three status contact inputs, **setting group selection 1 (TC_AJ_1)**, **setting group selection 2 (TC_AJ_2)** and **setting group selection 3 (TC_AJ_3)**, be programmed for it by means of the function of programmable status contact inputs. There is another possible input whose function is to disallow group changes: **inhibit setting group control (INH_SGC)**.

The activation of inputs **TC_AJ_1, TC_AJ_2 and TC_AJ_3** while the inhibit setting group control input (**INH_SGC**) is inactive will activate GROUP 1, GROUP 2 and GROUP 3 respectively. When the **INH_SGC** input is active, you will not be able to switch groups by means of **TC_AJ_1, TC_AJ_2** or **TC_AJ_3**.

If, while one of the inputs is active, either of the other two or both are activated, no group change will take place. The status contact settings group control logic will recognize a single input only. If all three inputs are deactivated, however, the IED will remain in the last active settings group.

Note: You can change groups by switching on T1, T2 and T3 only if the display is in the default screen.

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6.16 Event Record

Each of the functions used by the system will log an event in the **Event record** when any of the situations listed in table 6-2 occur. The functions installed are: **Protection, Initialization, Digital inputs** and **Control**.

Table 6-2: Event List

Function	Event	Octet	Bit
Time and instantaneous overcurrent element outputs, pickup and trip output activated (depending on the model) [OC]	Phase A time overcurrent pickup	1	1
	Phase B time overcurrent pickup	1	2
	Phase C time overcurrent pickup	1	3
	Ground time overcurrent pickup	1	4
	Phase A instantaneous overcurrent pickup (7IVD-K/L)	1	5
	Phase B instantaneous overcurrent pickup (7IVD-K/L)	1	6
	Phase C instantaneous overcurrent pickup (7IVD-K/L)	1	7
	Ground instantaneous overcurrent pickup (7IVD-K/L)	1	8
	Phase A instantaneous overcurrent pickup 1 (7IVD-J)	1	5
	Phase B instantaneous overcurrent pickup 1 (7IVD-J)	1	6
	Phase C instantaneous overcurrent pickup 1 (7IVD-J)	1	7
	Ground instantaneous overcurrent pickup 1 (7IVD-J)	1	8
	Phase A time overcurrent trip output active	2	1
	Phase B time overcurrent trip output active	2	2
	Phase C time overcurrent trip output active	2	3
	Ground time overcurrent trip output active	2	4
	Phase A instantaneous overcurrent trip output active (7IVD-K/L)	2	5
	Phase B instantaneous overcurrent trip output active (7IVD-K/L)	2	6
	Phase C instantaneous overcurrent trip output active (7IVD-K/L)	2	7
	Ground instantaneous overcurrent trip output active (7IVD-K/L)	2	8
	Phase A instantaneous current trip output 1 active (7IVD-J)	2	5
	Phase B instantaneous current trip output 1 active (7IVD-J)	2	6
	Phase C instantaneous current trip output 1 active (7IVD-J)	2	7
	Ground instantaneous current trip output 1 active (7IVD-J)	2	8
	Phase C instantaneous undercurrent trip output active	3	2
	Phase B instantaneous undercurrent trip output active	3	3
	Phase A instantaneous undercurrent trip output active	3	4

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
Time and instantaneous overcurrent element outputs, pickup and trip output activated (depending on the model) [OC]	Frequency element 2 output active	3	5
	Phase C undervoltage pickup	3	6
	Phase B undervoltage pickup	3	7
	Phase A undervoltage pickup	3	8
	Phase C overcurrent trip output active	4	2
	Phase B overcurrent trip output active	4	3
	Phase A overcurrent trip output active	4	4
	Frequency element 2 output active	4	5
	Phase C overvoltage pickup	4	6
	Phase B overvoltage pickup	4	7
	Phase A overvoltage pickup	4	8
[14]	Phase A directional time element pickup (7IVD-L)	1	1
	Phase B directional time element pickup (7IVD-L)	1	2
	Phase C directional time element pickup (7IVD-L)	1	3
	Ground directional time element pickup (7IVD-L)	1	4
	Phase A directional instantaneous element pickup (7IVD-L)	2	5
	Phase B directional instantaneous element pickup (7IVD-L)	2	6
	Phase C directional instantaneous element pickup (7IVD-L)	2	7
	Directional ground instantaneous element pickup (7IVD-L)	2	8
	Phase A directional time element output active (7IVD-L)	3	1
	Phase B directional time element output active (7IVD-L)	3	2
	Phase C directional time element output active (7IVD-L)	3	3
	Ground directional time element output active (7IVD-L)	3	4
	Phase A directional instantaneous element output active (7IVD-L)	3	5
	Phase B directional instantaneous element output active (7IVD-L)	3	6
	Phase C instantaneous directional element output active (7IVD-L)	3	7
	Ground instantaneous directional element output active (7IVD-L)	3	8

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
Time and instantaneous overcurrent element outputs reset and trip output deactivate (depending on the model)	Phase A time overcurrent reset	1	1
	Phase B time overcurrent reset	1	2
	Phase C time overcurrent reset	1	3
	Ground time overcurrent reset	1	4
	Phase A instantaneous overcurrent reset (7IVD-K/L)	1	5
	Phase B instantaneous overcurrent reset (7IVD-K/L)	1	6
	Phase C instantaneous overcurrent reset (7IVD-K/L)	1	7
	Ground instantaneous overcurrent reset (7IVD-K/L)	1	8
	Phase A instantaneous overcurrent 1 reset (7IVD-J)	1	5
	Phase B instantaneous overcurrent 1 reset (7IVD-J)	1	6
	Phase C instantaneous overcurrent 1 reset (7IVD-J)	1	7
	Ground instantaneous overcurrent 1 reset (7IVD-J)	1	8
	Phase A time overcurrent trip output deactivate	2	1
	Phase B time overcurrent trip output deactivate	2	2
	Phase C time overcurrent trip output deactivate	2	3
	Ground time overcurrent trip output deactivate	2	4
	Phase A instantaneous overcurrent trip output deactivate (7IVD-K/L)	2	5
	Phase B instantaneous overcurrent trip output deactivate (7IVD-K/L)	2	6
	Phase C instantaneous overcurrent trip output deactivate (7IVD-K/L)	2	7
	Ground instantaneous overcurrent trip output deactivate (7IVD-K/L)	2	8
	Phase A instantaneous overcurrent trip output 1 deactivate (7IVD-J)	2	5
	Phase B instantaneous overcurrent trip output 1 deactivate (7IVD-J)	2	6
	Phase C instantaneous overcurrent trip output 1 deactivate (7IVD-J)	2	7
	Ground instantaneous overcurrent trip output 1 deactivate (7IVD-J)	2	8
	Phase C undervoltage trip output deactivate	3	2
	Phase B undervoltage trip output deactivate	3	3
	Phase A undervoltage trip output deactivate	3	4
	Frequency element 1 output deactivate	3	5
	Phase C undervoltage reset	3	6
	Phase B undervoltage reset	3	7
	Phase C undervoltage reset	3	8
	Phase C overvoltage trip output deactivate	4	2
	Phase B overvoltage trip output deactivate	4	3
	Phase A overvoltage trip output deactivate	4	4
	Frequency element 2 output deactivate	4	5
	Phase C overvoltage reset	4	6
	Phase B overvoltage reset	4	7
	Phase A overvoltage reset	4	8

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
[15]	Phase A directional element deactivated (7IVD-L)	1	1
	Phase B directional element deactivated (7IVD-L)	1	2
	Phase C directional element deactivated (7IVD-L)	1	3
	Ground directional element deactivated (7IVD-L)	1	4
	Phase A directional time element reset (7IVD-L)	2	1
	Phase B directional time element reset (7IVD-L)	2	2
	Phase C directional time element reset (7IVD-L)	2	3
	Ground directional time element output active (7IVD-L)	2	4
	Phase A directional instantaneous element reset (7IVD-L)	2	5
	Phase B directional instantaneous element reset (7IVD-L)	2	6
	Phase C directional instantaneous element reset (7IVD-L)	2	7
	Ground directional instantaneous element reset (7IVD-L)	2	8
	Phase A directional time element output deactivate (7IVD-L)	3	1
	Phase B directional time element output deactivate (7IVD-L)	3	2
	Phase C directional time element output deactivate (7IVD-L)	3	3
	Ground directional time element output deactivate (7IVD-L)	3	4
	Phase A directional instantaneous time element output deactivate (7IVD-L)	3	5
	Phase B directional instantaneous time element output deactivate (7IVD-L)	3	6
	Phase C directional instantaneous time element output deactivate (7IVD-L)	3	7
	Ground directional instantaneous time element output deactivate (7IVD-L)	3	8
Pickups and activations of directional element, residual current, open phase, breaker failure and instantaneous 2 (depending on the model) [11]	Phase A directional element pickup (7IVD-L)	1	1
	Phase B directional element pickup (7IVD-L)	1	2
	Phase C directional element pickup (7IVD-L)	1	3
	Ground directional element pickup (7IVD-L)	1	4
	Residual current pickup	2	1
	Residual current output active	2	2
	Open phase pickup	2	3
	Open phase output active	2	4
	Breaker failure output active	2	5
	Trip circuit failure output active	2	6
	Close circuit failure output active	2	7

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
Pickups and activations of directional element, residual current, open phase, breaker failure and instantaneous 2 (depending on the model) [11]	Trip signaling failure output active (power #1)	2	8
	Close output failure output active (power #3)	3	1
	Protection alarm output active (out of service)	3	2
	Breaker monitoring alarm level exceeded	3	3
	Breaker monitoring alarm level overflow	3	4
	Oscillography startup (optional)	3	5
	Phase A instantaneous overcurrent pickup (7IVD-J)	4	5
	Phase B instantaneous overcurrent pickup (7IVD-J)	4	6
	Phase C instantaneous overcurrent pickup (7IVD-J)	4	7
	Ground instantaneous overcurrent pickup (7IVD-J)	4	8
	Phase A instantaneous current trip output 2 active (7IVD-J)	4	1
	Phase B instantaneous current trip output 2 active (7IVD-J)	4	2
	Phase C instantaneous current trip output 2 active (7IVD-J)	4	3
	Instantaneous output 2 active: ground (7IVD-J)	4	4
Reset and deactivation of residual current, open phase and instantaneous 2 [12]	Residual current reset	2	1
	Residual current output deactivate	2	2
	Open phase reset	2	3
	Open phase output deactivate	2	4
	Protection alarm output deactivate (out of service)	2	5
	Phase A instantaneous overcurrent 2 reset (7IVD-J)	4	1
	Phase B instantaneous overcurrent 2 reset (7IVD-J)	4	2
	Phase C instantaneous overcurrent 2 reset (7IVD-J)	4	3
	Ground instantaneous overcurrent 2 reset (7IVD-J)	4	4
	Phase A instantaneous overcurrent trip output 2 deactivate (7IVD-J)	4	5
	Phase B instantaneous overcurrent trip output 2 deactivate (7IVD-J)	4	6
	Phase C instantaneous overcurrent trip output 2 deactivate (7IVD-J)	4	7
	Ground instantaneous overcurrent trip output 2 deactivate (7IVD-J)	4	8
Initialization [13]	Cold load pickup	1	8
	Change of settings initialization	1	7
Contact inputs [06]	Status contact input IN-1 active	1	1
	Status contact input IN-2 active	1	2
	Status contact input IN-3 active	1	3
	Status contact input IN-4 active	1	4
	Status contact input IN-5 active	1	5
	Status contact input IN-6 active	1	6
	Status contact input IN-7 active	1	7
	Status contact input IN-8 active	1	8

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
Contact inputs [06]	Status contact input IN-1 deactivated	2	1
	Status contact input IN-2 deactivated	2	2
	Status contact input IN-3 deactivated	2	3
	Status contact input IN-4 deactivated	2	4
	Status contact input IN-5 deactivated	2	5
	Status contact input IN-6 deactivated	2	6
	Status contact input IN-7 deactivated	2	7
	Status contact input IN-8 deactivated	2	8
	Status contact input IN-1 disable	3	1
	Status contact input IN-2 disable	3	2
	Status contact input IN-3 disable	3	3
	Status contact input IN-4 disable	3	4
	Status contact input IN-5 disable	3	5
	Status contact input IN-6 disable	3	6
	Status contact input IN-7 disable	3	7
	Status contact input IN-8 disable	3	8
Command [05]	Trip blocked due to setting disagreement	1	2
	Current detected with open breaker status	1	3
	Close command failure	1	4
	Open command failure	1	5
	Breaker close command	1	7
	Breaker open command	1	8
	Group 1 enable from command	2	1
	Group 2 enable from command	2	2
	Group 3 enable from command	2	3
	Block reclosing of ground measuring elements (7IVD-L)	2	4
	Unblocking of ground measuring elements (7IVD-L)	2	5
	Excessive number of trips	2	6
Recloser [04]	Recloser external lockout reset	1	3
	Recloser external lockout	1	4
	Recloser unlocked	1	5
	Recloser blocked	1	6
	Recloser lockout due to switch-on-to-fault	1	7
	Recloser lockout due to lack of rated voltage	1	8
	Recloser lockout due to breaker failure	2	1
	Recloser lockout due to permanent fault	2	2
	Recloser lockout due to open breaker status	2	3
	Recloser lockout due to unsatisfied reclosing conditions	2	4
	Recloser lockout due to sequence check failure	2	5
	Reclose command	2	6
	Recloser reset	2	7
	Reclose sequence in progress	2	8

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Table 6-2: Event List			
Function	**Event**	**Octet**	**Bit**
HMI [09]	Settings group 1 activated by status contact input	1	1
	Settings group 2 activated by status contact input	1	2
	Settings group 3 activated by status contact input	1	3
	Local mode (keypad and display)	1	5
	Local mode (front port)	1	6
	Remote mode (rear port)	1	7

- **Organization of the event record**

The event record capacity is one hundred (100) events. When the record is full, a new event displaces the oldest event. The following information is stored in each event register:

- Phase and ground current as well as phase voltage measured at the time the event is generated.
- Event date and time.
- Description of the event.

Event recorder management is optimized so that simultaneous operations generated by the same event occupy a single position in the event memory. For example, the simultaneous occurrence of the phase A and ground time overcurrent pickups are recorded in the same memory position. However, if the occurrences are not simultaneous, two separate events are generated. Simultaneous events are those operations occurring within a 1 ms interval, the resolution time of the recorder.

Use the general settings in communications to mask unneeded or unused events for system behavior analysis.

Important: Events that can be generated in excess should be masked since they could fill the memory (100 events) and erase more important previous events. For example, when the load on the line is light, the open phase element can pickup and reset constantly.

- **Consulting the record**

Use the IED's HMI sequence, **Information** - **Registers** - **Event record** (access password not needed), to access event record information. Chapter 8 explains how to consult the event record from the HMI.

The communications and remote management program, ***ZIVercom***®, has a completely decoded system for consulting the event record. Information is displayed as shown in the table. If the IED has the **oscillographic register** function, you can only consult the event record via communications.

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6.17 Fault Reports

You can consult the system's **Fault reports** register, which stores the most relevant information about faults cleared by the IED. The information stored in each register of this record, by access mode, is:

- **Via communications**

Fault initiation time tag. It presents the date and time of the pickup of the first unit involved in the fault. It also includes:

- **Pre-fault currents and voltages**. They are the values of the three phase and ground currents and of the phase voltages two cycles before the initiation of the fault.

  Model **7IVD-L** also records the values of the *inverse sequence* and *zero sequence currents*.

  The values saved are those measured two cycles before the onset of the fault, that is, before the pickup of the element generating the fault report.

- **Elements picked up** (depending on the model) for full fault duration.

Open command time tag. It presents the date and time of the trip command. It also presents:

- **Pre-fault currents and voltages**, as in the preceding case, the instant the trip command is generated.

- **Elements tripped** (depending on the model).

  Model **7IVD-L** also records the values of the *inverse sequence* and *zero sequence currents*.

  The values saved are those measured two and a half cycles after the onset of the fault, that is, after the pickup of the element generating the fault report.

Fault end time tag. It is the date and time of the reset of the last element involved in the fault. It also presents:

- **Current interrupted by the breaker**: it is the maximum phase current registered between the instant the trip command is given and the termination of the fault (due to the breaker opening or to failure of the open command).

Each annotation of the fault report specifies the active group at the time of the trip. Model **7IVD-L** also saves the *reclose attempt* prior to the trip.

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- **From the display**

Although all the information is stored and is available for consultation through both communication ports, only the following fault report data can be accessed from the local display:

- **Fault initiation time tag**. It is the date and time of the pickup of the first element involved in the fault.
- **Open command time tag**.
- **Fault end time tag**. It is the date and time of the reset of the last element involved in the fault.
- Element initiating the trip and elements picked up (depending on the model) for full fault duration (press F4 from the time tag screen).

Chapter 8, Alphanumeric keyboard and display, explains the layout and how to access these fault protection data though the HMI. If the IED has the **Oscillographic register** function, the **Fault report** will not be accessible through the HMI.

6.18 Current, Voltage and Power History Record

This function records the evolution of the values monitored at the point where the IED is installed. It samples each of the phase currents/voltages every second and calculates their average over the interval defined as **averaging calculation time interval**. This time interval is adjustable between 1 and 15 minutes. Each interval yields two current/voltage values: the highest and the lowest of the three phase magnitude averages.

The **data record interval** is an adjustable period of time between 1 minute and 24 hours. The maximum and minimum averages recorded in the whole interval are recorded with their final time stamp. Figure 6.26 shows how the history record works.

AT: Average calculation time interval; the figure shows an AT value of one minute.

RI: Data record interval; the figure shows an RI of 15 minutes.

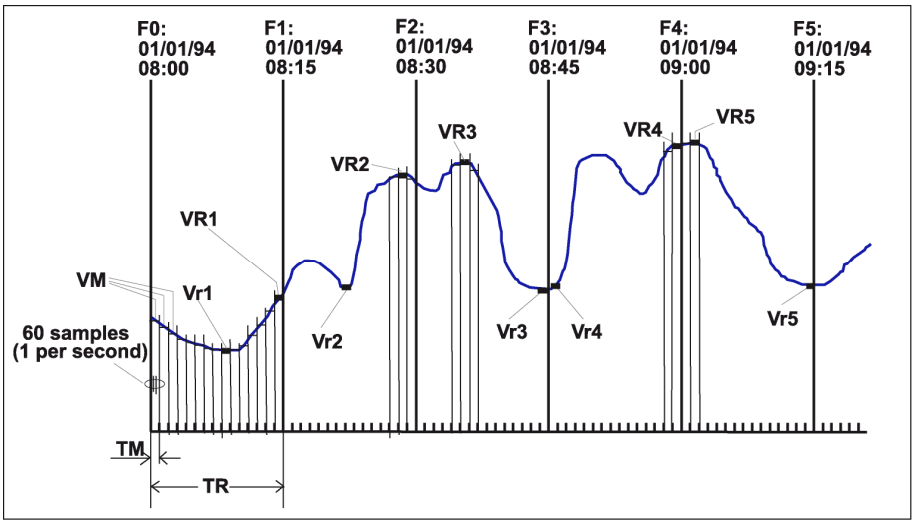

Figure 6.26: Explanatory Diagram of the History Record.

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Each **AT** yields two **MV** values: the maximum and minimum averages of the three phases. Each **RI** interval takes the maximum and minimum values of all the **MVs** computed. The current profile of figure 6.26 yields the following values: VR1 - Vr1; VR2 - Vr2; VR3 - Vr3; VR4 - Vr4 and VR5 - Vr5.

Note: if phase or ground elements pick up during the average calculation time interval, the average of the measurements made while the elements were not picked up is recorded. Otherwise, if the elements remain picked up throughout the TM, the value recorded is: 0A / 0V.

The memory available for the history record is RAM, capable of storing 168 values (equivalent to 7 days of 1-hour intervals). You can customize the memory by defining an **Hour range** and **Day calendar mask** (the same hour range for all the days). No values outside the mask will be recorded.

The memory can store 100 records with all the indicated values.

Access the history record data through the HMI with the sequence, **Data - Event recording - Current history / Voltage history / Power history**, as explained in Chapter 8, Alphanumeric keyboard and display. If the IED has an oscillographic register function, you can access these data only via communications.

6.18.1 Recording of Maximums and Minimums and History of Measurements (Load Profile, Model 7IVD-L)

All the foregoing is applicable to model **7IVD-L**, which records additional values as well. The data recorded are (maximum and minimum values of each magnitude):

- Currents: I_A, I_B, I_C, I_N, $I_{NS.}$
- Line-to-neutral voltages: V_A, V_B and $V_{C.}$
- Phase-to-phase voltages: V_{AB}, V_{BC} and $V_{CA.}$
- Active and reactive power.
- Energies: ACTIVE OUTPUT, INDUCTIVE REACTIVE, ACTIVE INPUT and CAPACITIVE REACTIVE. (Neither averages nor maximum and minimum values are calculated for these magnitudes, only their meter values at the time of recording are stored).

The value of these energies is sampled each minute and compared with the previously saved maximums and minimums. The conditions for updating the maximum and minimum values are:

- No protection device is picked up.
- ***Line-to-neutral voltages*** must be above 13 Vac in primary, and ***phase-to-phase voltages*** must exceed 26 Vac.
- ***Currents*** must be above 0.25 Aca in primary.
- Updating ***powers*** is subject to the thresholds defined for the line-to-neutral currents and voltages.

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6.19 Oscillographic Register (Optional)

The oscillography settings serve two different functions: **Capture** and **Display**. The first captures and stores protection data inside the IED and is part of the relay's software; the second retrieves and presents the stored data graphically with one or more programs running on a PC connected to the protection.

- **Capture function**

A record of status contact input signals is stored each time a sample is taken.

Model 7IVD-L stores samples of analog inputs as well as digital signals. All this information is stored in non-volatile memory.

- **Stored data**

The following data are stored with a resolution time equal to the sampling rate:

- Analog values of the samples selected for recording.
- Digital values of the samples of the selected status contact input signals (only in model **7IVD-L**). The status contact input signals group is the same as that of the outputs [group 6-4].
- Time stamp of the oscillography startup.

- **Number of channels**

Depending on the model, up to nine channels are available and you can enable or disable any of them with the relevant setting.

In model **7IVD-L**, use the ***ZIVercom***®communications and remote management program to select the status contact input signals. By default, the IED has all the status contact input signals masked.

- **Recording modes**

Select either of two recording modes: **Fixed time YES** and **Fixed time NO**. In the first mode, recording begins when the **Start** function is activated and ends according to the **Oscillograph length** setting. In the second mode, recording begins when the start function is activated and stops when the start function is deactivated.

- **Start function**

The start function is determined by a programmable mask applied to certain internal logic output signals (element pickups, open command, etc.) and to the **External oscillography start logic input** signal, (which must be assigned to any one of the physical status contact inputs if you want to use it).

If the start function mask setting is **YES**, this signal activates the oscillography startup. This signal will not start the oscillography function if its mask setting is **NO**.

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- **Pre-fault time**

This is the length of pre-fault data that must be stored before the start function initiates a record.

- **Oscillography record length**

It is the fault record duration in **Fixed time** mode.

- **Number of records**

The number of records stored in memory varies and depends on the number of channels recorded and the length of the fault records. Once the recording memory is full, the next event will overwrite the oldest one stored. Since event records vary in length, new ones will overwrite old ones as needed.

- **Record storage modes**

Start mode: recorded data are stored whenever the start function is activated. With fixed time set to **YES**, data are stored during the selected oscillography record length. With fixed time set to **NO**, data are stored as long as the start function is active.

Trip mode 1: data are stored only if there is a trip (that is, from pickup to trip). With fixed time set to **YES**, the trip must occur within the set oscillography record length. With fixed time set to **NO**, data are stored until the element is tripped.

Trip mode 2: if the fixed time setting is **YES** and no trip occurs within the set oscillography record length, data are stored during four cycles after the start function is activated. If, however, there is a trip within the set oscillography record length, data are stored during the set oscillography record length plus the pre-fault data.

If the fixed time setting is **NO** and no trip occurs while the start function is active, data are stored during 4 cycles after the start function is activated. If there is a trip while the start function is active, data are stored all the while that it remains active.

Note: for elements with long reset times, for example undervoltage elements, fixed time mode is recommended.

Note that data are always stored during the set pre-pickup time.

- **Overwrite**

If the setting is **NO**, once the oscillography memory is full, no more oscillographs are stored. If you set overwrite to **YES**, when the memory is full, the next oscillography will overwrite the oldest one.

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6.20 Contact Inputs, Outputs and LED Targets

7IVD IEDs have programmable **inputs and outputs** enabling user configuration of flexible logic designs as described in the following sections. You can use the ***ZIVercom***® software program to create and modify logic equations.

6.20.1 Contact Inputs

Certain metering elements and logic functions of the IED use the **Logic input signals** listed in table 6-3. You can assign them to the eight physical status contact inputs available for the protection subsystem. An optional expansion board doubles these inputs. Note that more than one logic input signal can be assigned to a single status contact input, but the same logic input signal can not be assigned to more than one status contact input.

Table 6-4:Logic Input Signals

No	Name	Description	Function
1	SSP_1	Trip coil circuit supervision with the breaker closed (*)	This function permits an alarm when an anomalous situation occurs in the breaker's switching circuits. Both breaker positions are monitored: open and closed. (*) SSP_1 and SSP_3 also supervise the operation of the IED's trip and close contacts.
2	SSP_3	Close coil circuit supervision with the breaker open (*)	
3	SBAIA	Trip coil circuit supervision with the breaker open	
4	SBCIC	Trip coil circuit supervision with the breaker closed	
5	EPT	External protection trip	It captures and uses the signal of an EPD for breaker failure and recloser initiate functions.
6	CED	Block trip	It blocks all trips if activated before they occur.
7	ATUT_F	Bypass time phase time overcurrent	Converts the timer of a given element to instantaneous
8	ATUT_N	Bypass time ground time overcurrent	
9	BDI_F	Block phase instantaneous overcurrent trip (7IVD-K/L)	Activation of the input before the trip is generated prevents the operation of the element. If activated after the trip, it resets.
9	BDI_F	Block phase instantaneous overcurrent trip 1 (7IVD-J)	
10	BDI_N	Block ground instantaneous overcurrent trip (7IVD-K/L)	
10	BDI_N	Block ground instantaneous overcurrent trip 1 (7IVD-J)	
11	BDT_F	Block phase time overcurrent trip	
12	BDT_N	Block ground time overcurrent trip	

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Table 6-4:Logic Input Signals			
No	**Name**	**Description**	**Function**
13	API_F	Torque control phase instantaneous (7IVD-K/L)	Resets the timing functions and keeps them at 0 as long as it is activated.
13	API_F	Torque control phase instantaneous 1 (7IVD-J)	
14	API_N	Torque control ground instantaneous (7IVD-K/L)	
14	API_N	Torque control ground instantaneous 1 (7IVD-J)	
15	APT_F	Torque control phase time overcurrent	
16	APT_N	Torque control ground time overcurrent	
17	CB	Open breaker status	It monitors the breaker status. Definable as contact generally open or as contact generally closed.
18	BE	Recloser external lockout	Its activation places the recloser function in lockout / unblocking statusrespectively.
19	DBE	Recloser external lockout reset	
20	BHZ1	Block trip of frequency time element 1	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets.
21	INHR	Reclose inhibit	It receives a signal that the recloser function uses to monitor inhibition.
22	RV	Rated voltage	It receives the voltage signal that the recloser function uses to monitor reclose by rated voltage
23	CEXT	Manual close command	It activates the close logic signal (conditions permitting)
25	INH_SGC	Inhibit change of setting group	They alternatively activate the relevant setting group (1, 2 or 3). This function is subordinated to the operation enable setting (configuration). The inhibit change of setting group input prevents group changes.
26	TC_AJ_1	Activate setting group #1	
27	TC_AJ_2	Activate setting group #2	
28	TC_AJ_3	Activate setting group #3	
29	BDI_F_V2	Block trip phase instantaneous 2 (7IVD-J)	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets.
30	BDI_N_V2	Block trip ground instantaneous 2 (7IVD-J)	
31	EX	Oscillography startup (optional)	It activates the oscillography start function (moreover, it must be programmed in the signal mask).
32	BHZ2	Block trip of frequency time element 2	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets.

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Table 6-4:Logic Input Signals			
No	**Name**	**Description**	**Function**
33	BDI_SUTa	Phase A instantaneous undervoltage element lockout	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets.
34	BDI_SUTb	Phase B instantaneous undervoltage element lockout	
35	BDI_SUTc	Phase C instantaneous undervoltage element lockout	
36	BDI_SOTa	Phase A instantaneous overvoltage element lockout	
37	BDI_SOTb	Phase B instantaneous overvoltage element lockout	
39	API_F_V2	Torque control phase instantaneous 2 (7IVD-J)	It resets the element's timing functions and keeps them at 0 as long as it is active.
41	C_DIR_TRIP	Inversion of the trip direction (7IVD-L)	When the input is in the default state, the operation zone is as indicated in figure 6.10. If activated, the operation zone is inverted.
43	IUD_N	Ground directional element inhibit (7IVD-L)	
44	ATUT_FD	Directional phase time delay element annul (7IVD-L)	It converts the set timing sequence of a given element to instantaneous.
46	BDI_FD	Block directional phase instantaneous overcurrent trip (7IVD-L)	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets
47	BDI_ND	Block directional ground instantaneous overcurrent trip (7IVD-L)	It resets the element's timing functions and keeps them at 0 as long as it is active.
48	BDT_FD	Block directional phase time overcurrent trip (7IVD-L)	
49	BDT_ND	Block directional ground time overcurrent trip (7IVD-L)	
50	API_FD	Torque control directional phase instantaneous (7IVD-L)	
51	API_ND	Torque control directional ground instantaneous overcurrent (7IVD-L)	
52	APT_FD	Torque control directional phase time overcurrent (7IVD-L)	
53	APT_ND	Torque control directional ground time overcurrent (7IVD-L)	

You can easily program different **Input settings** using the local communications port and the ***ZIVercom***® software program.

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6.20.2 Auxiliary Contact and Trip Outputs

The protection subsystem of models **7IVD-J**, **7IVD-K** and **7IVD-L** have 8 physical outputs, seven of which are definable, and 8 virtual outputs, seven of which are definable. If you add a protection expansion board, the virtual outputs become physical. Operational principles are described in the following paragraphs:

The protection and monitoring functions generate a series of logic output signals. Each of these signals has either a “true” or “false” value and this status can be used as an input to either of the combinational logic gates shown in figure 6.27. The communications interface sends all of these outputs to the control subsystem. The IED has fourteen outputs of this type and the first seven are used physically. An expansion board makes the fourteen outputs available.

Two blocks of eight inputs are available. One of the blocks performs an **OR** operation with the selected signals (any signal activates the logic gate output). The other block performs an **AND** operation with the selected signals (all signals need to be active to activate the logic gate output). The result of these two blocks is then operated through either an **AND** or an **OR** gate. The pulse option can be added to the result of this operation. It works as follows:

- **Without pulses:** by adjusting the pulse timer to 0, the output signal remains active as long as the signal that activated it lasts.
- **With pulses:** once the output signal is activated, it remains the set time whether or not the signal that generated it is deactivated before or remains active.

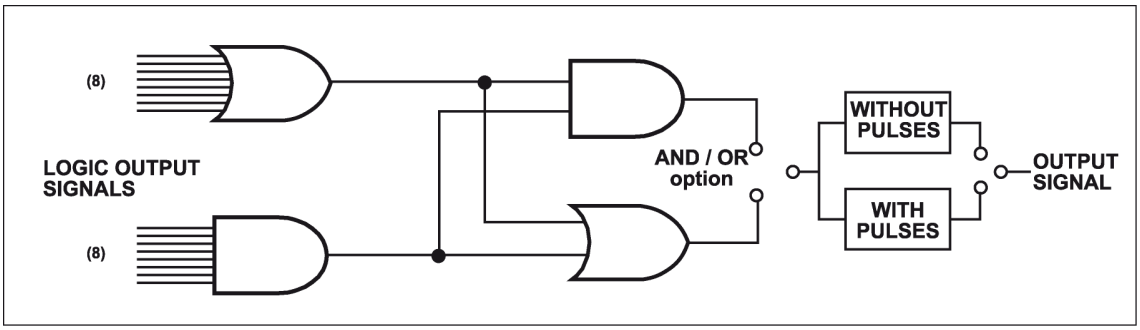

Figure 6.27: Output Logic Block Diagram.

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Table 6-4 lists the available logic output signals:

Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
1	SUT_A	Phase A time overcurrent trip output	Trip of the current elements.
2	SUT_B	Phase B time overcurrent trip output	
3	SUT_C	Phase C time overcurrent trip output	
4	SUT_N	Ground time overcurrent trip output	
5	SUI_A	Phase A instantaneous overcurrent trip output (7IVD-K/L)	
5	SUI_A	Phase A instantaneous overcurrent trip output 1 (7IVD-J)	
6	SUI_B	Phase B instantaneous overcurrent trip output (7IVD-K/L)	
6	SUI_B	Phase B instantaneous overcurrent trip output 1 (7IVD-J)	
7	SUI_C	Phase C instantaneous overcurrent trip output (7IVD-K/L)	
7	SUI_C	Phase C instantaneous overcurrent trip output 1 (7IVD-J)	
8	SUI_N	Ground instantaneous overcurrent trip output (7IVD-K/L)	
8	SUI_N	Ground instantaneous overcurrent trip output 1 (7IVD-J)	
9	AUT_A	Phase A time overcurrent trip pickup	Pickup of the current elements unaffected by torque control.
10	AUT_B	Phase B time overcurrent trip pickup	
11	AUT_C	Phase C time overcurrent trip pickup	
12	AUT_N	Ground time overcurrent pickup	
13	AUI_A	Phase A instantaneous overcurrent pickup (7IVD-K/L)	
13	AUI_A	Phase A instantaneous overcurrent pickup 1 (7IVD-J)	
14	AUI_B	Phase B instantaneous overcurrent pickup (7IVD-K/L)	
14	AUI_B	Phase B instantaneous overcurrent pickup 1 (7IVD-J)	
15	AUI_C	Phase C instantaneous overcurrent pickup (7IVD-K/L)	
15	AUI_C	Phase C instantaneous overcurrent pickup 1 (7IVD-J)	
16	AUI_N	Ground instantaneous overcurrent pickup (7IVD-K/L)	
16	AUI_N	Ground instantaneous overcurrent pickup 1 (7IVD-J)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
17	ATDD_A	Phase A time overcurrent torque-controlled pickup	AND logic of the pickup of the current elements with the corresponding torque-control input.
18	ATDD_B	Phase B time overcurrent torque-controlled pickup	
19	ATDD_C	Phase C time overcurrent torque-controlled pickup	
20	ATDD_N	Ground time overcurrent torque-controlled pickup	
21	AIDD_A	Phase A instantaneous overcurrent torque-controlled pickup (7IVD-K/L)	
21	AIDD_A	Phase A instantaneous overcurrent torque-controlled pickup 1 (7IVD-J)	
22	AIDD_B	Phase B instantaneous overcurrent torque-controlled pickup (7IVD-K/L)	
22	AIDD_B	Phase B instantaneous overcurrent torque-controlled pickup 1 (7IVD-K/L)	
23	AIDD_C	Phase C instantaneous overcurrent torque-controlled pickup (7IVD-K/L)	
23	AIDD_C	Phase C instantaneous overcurrent torque-controlled pickup 1 (7IVD-J)	
24	AIDD_N	Ground instantaneous overcurrent torque-controlled pickup (7IVD-K/L)	AND logic of the pickup of the current elements with the corresponding torque-control input
24	AIDD_N	Ground instantaneous overcurrent torque-controlled pickup 1 (7IVD-J)	Pickup of the overvoltage units and initiation of the integration.
25	ASOT_A	Phase A instantaneous overvoltage pickup	
26	ASOT_B	Phase B instantaneous overvoltage pickup	
27	ASOT_C	Phase C instantaneous overvoltage pickup	
28	S_FREC1	Frequency element 1 output active	Trip of frequency element 1.
29	SSOT_A	Phase A instantaneous overvoltage output element active	Trip of the phase elements and trip (S_SOT) of the overvoltage logic.
30	SSOT_B	Phase B instantaneous overvoltage output element active	
31	SSOT_C	Phase C instantaneous overvoltage output element active	
32	S_SOT	Instantaneous overvoltage output element active	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
33	IL	Line current	Detects current through the phases.
34	A_FASE_A	Open phase detection element pickup	Pickup of the open phase and residual current elements.
35	A_RESIDUAL	Residual current detection element pickup	
36	S_FASE_A	Operation of open phase detection element	Trip of the open phase and residual current detection elements.
37	S_RESIDUAL	Operation of the residual current detection element	
38	FSP_1	Trip output failure-supply power 1	Indicates that the trip signaling associated with the SSP_1 input has failed.
39	FSP_3	Trip output failure-supply power 3	Indicates that the close output associated with the SSP_3 input has failed.
40	TCF	Trip circuit supervision failure (7IVD-J)	Alarm signal due to failure in the breaker's switching circuits.
41		Trip circuit supervision failure (7IVD-K/L)	
41	CCF	Close circuit supervision failure (7IVD-J)	
42		Close circuit supervision failure (7IVD-K/L)	
42	BF	Breaker failure output (7IVD-J)	Signal for alarm or trip initiation of other breakers.
43		Breaker failure output (7IVD-K/L)	
43	A_SINT	KA^2 sum alarm level (7IVD-J)	Accumulated power alarm signal opened by the breaker.
45		KA^2 sum alarm level (7IVD-K/L)	
44	ASUT_A	Phase A instantaneous undervoltage pickup (7IVD-J)	Pickup of the undervoltage units and initiation of the integration.
46		Phase A instantaneous undervoltage pickup (7IVD-K/L)	
45	ASUT_B	Phase B instantaneous undervoltage pickup (7IVD-J)	
47		Phase B instantaneous undervoltage pickup (7IVD-K/L)	
46	ASUT_C	Phase C instantaneous undervoltage pickup (7IVD-J)	
48		Phase C instantaneous undervoltage pickup (7IVD-K/L)	
47	S_FREC2	Frequency element 2 output active (7IVD-J)	Trip of frequency element 2.
49		Frequency element 2 output active (7IVD-K/L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
48	SSUT_A	Phase A instantaneous undervoltage output element active (7IVD-J)	Trip of the phase and trip (S_SUT) elements of the undervoltage logic.
50		Phase A instantaneous undervoltage output element active (7IVD-K/L)	
49	SSUT_B	Phase B instantaneous undervoltage output element active (7IVD-J)	
51		Phase B instantaneous undervoltage output element active (7IVD-K/L)	
50	SSUT_C	Phase C instantaneous undervoltage output element active (7IVD-J)	
52		Phase C instantaneous undervoltage output element active (7IVD-K/L)	
51	S_SUT	Instantaneous undervoltage element active (7IVD-J)	
53		Instantaneous undervoltage element active (7IVD-K/L)	
52	OPEN	Open command (7IVD-J)	Sends the open / close command to the breaker.
54		Open command (7IVD-K/L)	
53	CLOSE	Close command (7IVD-J)	
55		Close command (7IVD-K/L)	
54	TRIP	Internal protection trip output (7IVD-J)	OR logic of all the elements.
56		Internal protection trip output (7IVD-K/L)	
55	OCF	Open or trip command failure (7IVD-J)	For manual maneuvers as well as those generated by the protection or reclose elements, these outputs indicate non-notification of the breaker status change after sending the switching command and within the maneuver failure time (independently adjustable for opening and closing).
57		Open or trip command failure (7IVD-K/L)	
56	CCF	Close command failure (7IVD-J)	
58		Close command failure (7IVD-K/L)	
57	IIA	Current detected with open breaker status (7IVD-J)	AND logic of the breaker and line current detection status.
59		Current detected with open breaker status (7IVD-K/L)	
58	RI	Reclose initiate (7IVD-J)	It switches the recloser state from reset to sequence check time.
61		Reclose initiate (7IVD-K/L)	
59	SUTM_A	Phase A time overcurrent mask enabled trip output (7IVD-J)	They trip the elements affected by their corresponding trip mask.
62		Phase A time overcurrent mask enabled trip output (7IVD-K/L)	
60	SUTM_B	Phase B time overcurrent mask enabled trip output (7IVD-J)	
63		Phase B time overcurrent mask enabled trip output (7IVD-K/L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
61	SUTM_C	Phase C time overcurrent mask enabled trip output (7IVD-J)	They trip the elements affected by their corresponding trip mask.
64		Phase C time overcurrent mask enabled trip output (7IVD-K/L)	
62	SUTM_N	Ground time overcurrent mask enabled trip output (7IVD-J)	
65		Ground time overcurrent mask enabled trip output (7IVD-K/L)	
63	SUIM_A	Phase A instantaneous overcurrent mask enabled trip output 1 (7IVD-J)	
66	SUIM_A	Phase A instantaneous overcurrent mask enabled trip output (7IVD-K/L)	
64	SUIM_B	Phase B instantaneous overcurrent mask enabled trip output 1 (7IVD-J)	
67	SUIM_B	Phase B instantaneous overcurrent mask enabled trip output (7IVD-K/L)	
65	SUIM_C	Phase C instantaneous overcurrent mask enabled trip output 1 (7IVD-J)	
68	SUIM_C	Phase C instantaneous overcurrent mask enabled trip output (7IVD-J)	
66	SUIM_N	Ground instantaneous overcurrent mask enabled trip output 1 (7IVD-J)	
69	SUIM_N	Ground instantaneous overcurrent mask enabled trip output (7IVD-K/L)	
68	FASEM_A	Open phase mask enabled output (7IVD-J)	
70		Open phase mask enabled output (7IVD-K/L)	
67	RESIDUALM	Residual current mask enabled output (7IVD-J)	They trip the elements affected by their corresponding trip mask.
71		Residual current mask enabled output (7IVD-K/L)	
69	SM_SUT	Instantaneous undervoltage mask enabled element output (7IVD-J)	
72		Instantaneous undervoltage mask enabled element output (7IVD-K/L)	
70	SM_SOT	Instantaneous overvoltage mask enabled element output (7IVD-J)	
73		Instantaneous overvoltage mask enabled element output (7IVD-K/L)	
71	BI	Recloser lockout for whatever reason (7IVD-J)	Any of the following lockouts.
74		Recloser lockout for whatever reason (7IVD-K/L)	
72	SBI_NTR	Recloser lockout due to lack of rated voltage (7IVD-J)	The rated voltage input does not activate before the rated voltage delay time times out (if the monitoring of reclosings by reference voltage setting is enabled).
75		Recloser lockout due to lack of rated voltage (7IVD-K/L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
73	SBI_DD	Recloser lockout due to permanent fault (7IVD-J)	It activates when all the reclose attempts have been made and the fault persists.
76		Recloser lockout due to permanent fault (7IVD-K/L)	
74	SBI_FC	Recloser lockout due to breaker close failure (7IVD-J)	The breaker has not closed within the breaker close failure time (logic settings - breaker close failure timer)
77		Recloser lockout due to breaker close failure (7IVD-K/L)	
75	SBI_BF	Recloser lockout due to breaker failure (7IVD-J)	The sequence check times out without the fault resetting or the breaker opening.
78		Recloser lockout due to breaker failure (7IVD-K/L)	
76	SBI_FL	Recloser lockout due to switch-on-to-fault (7IVD-J)	If, after a manual close or a change of setting, there is a trip before the reset time times out after a manual close.
79		Recloser lockout due to switch-on-to-fault (7IVD-K/L)	
77	SBI_IA	Recloser lockout due to open breaker status (7IVD-J)	Breaker opening not associated with a fault.
80		Recloser lockout due to open breaker status (7IVD-K/L)	
78	SBI_NCR	Recloser lockout due to unsatisfied reclosing conditions (7IVD-J)	Signal associated with switching inhibit input.
81		Recloser lockout due to unsatisfied reclosing conditions (7IVD-K/L)	
79	RCC_1	Reclose attempt 1 (7IVD-J)	They indicate the recloser's current attempt.
82		Reclose attempt 1 (7IVD-K/L)	
80	RCC_2	Reclose attempt 2 (7IVD-J)	
83		Reclose attempt 2 (7IVD-K/L)	
81	RCC_3	Reclose attempt 3 (7IVD-J)	
84		Reclose attempt 3 (7IVD-K/L)	
82	RCC_4	Reclose attempt 4 (7IVD-J)	
85		Reclose attempt 4 (7IVD-K/L)	
83	DD	Presence of permanent fault or switch-on-to-fault (7IVD-J)	The fault persists after the reclosing sequence or recloser lockout due to switch-on-to-fault.
86		Presence of permanent fault or switch-on-to-fault (7IVD-K/L)	
84	BLQ	Recloser blocked or recloser external lockout (7IVD-J)	Recloser function blocked manually or externally.
87		Recloser blocked or recloser external lockout (7IVD-K/L)	
85	RC	Reclose command (7IVD-J)	Close command sent from the control module.
88		Reclose command (7IVD-K/L)	
86	RSP	Reclose sequence in progress (7IVD-J)	RC of reclosing sequence.
89		Reclose sequence in progress (7IVD-K/L)	
87		Recloser blocked(7IVD-J)	
90		Recloser blocked (7IVD-K/L)	
88		Recloser external lockout(7IVD-J)	
91		Recloser external lockout (7IVD-K/L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
90	SRP	Recloser reset(7IVD-J)	Recloser function in recloser reset state after fault reset time or reset time after external closure without there having been a fault.
93		Recloser reset (7IVD-K/L)	
91	SRES	Recloser in service(7IVD-J)	Signal corresponding to the recloser in service setting.
94		Recloser in service (7IVD-K/L)	
92		Alarm detected in the environment module (7IVD-J)	
92	PMC	Recloser in Manual Close Sequence (7IVD-K/L)	Signal active from external close command until recloser resets.
93		Alarm detected in the fault module (7IVD-J)	
94	ENT_FIS1	Status contact input 1 (Board 1) (7IVD-J)	Active outputs in terms of the corresponding input.
99		Status contact input 1 (Board 1) (7IVD-K/L)	
95	ENT_FIS2	Status contact input 2 (Board 1) (7IVD-J)	
100		Status contact input 2 (Board 1) (7IVD-K/L)	
96	ENT_FIS3	Status contact input 3 (Board 1) (7IVD-J)	
101		Status contact input 3 (Board 1) (7IVD-K/L)	
97	ENT_FIS4	Status contact input 4 (Board 1) (7IVD-J)	
102		Status contact input 4 (Board 1) (7IVD-K/L)	
98	ENT_FIS5	Status contact input 5 (Board 1) (7IVD-J)	
103		Status contact input 5 (Board 1) (7IVD-K/L)	
99	ENT_FIS6	Status contact input 6 (Board 1) (7IVD-J)	
104		Status contact input 6 (Board 1)	
100	ENT_FIS7	Status contact input 7 (Board 1) (7IVD-J)	
105		Status contact input 7 (Board 1) (7IVD-K/L)	
101	ENT_FIS8	Status contact input 8 (Board 1)	
106		Status contact input 8 (Board 1) (7IVD-K/L)	
102		Protection module alarm (7IVD-J)	
107	ENT_FIS9	Status contact input 1 (Board 2) (7IVD-K/L)	Active outputs in terms of the corresponding input.
108	ENT_FIS10	Status contact input 2 (Board 2) (7IVD-K/L)	
109	ENT_FIS11	Status contact input 3 (Board 2) (7IVD-K/L)	
110	ENT_FIS12	Status contact input 4 (Board 2) (7IVD-K/L)	
111	ENT_FIS13	Status contact input 5 (Board 2) (7IVD-K/L)	
112	ENT_FIS14	Status contact input 6 (Board 2) (7IVD-K/L)	
113	ENT_FIS15	Status contact input 7 (Board 2) (7IVD-K/L)	
114	ENT_FIS16	Status contact input 8 (Board 2) (7IVD-K/L)	
110	S_M_FREC1	Frequency element mask enabled output 1 (7IVD-J)	
115		Frequency element mask enabled output 1 (7IVD-K/L)	
111	S_M_FREC2	Frequency element mask enabled output 2 (7IVD-J)	
116		Frequency element mask enabled output 2 (7IVD-K/L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
112	SUI_A2	Phase A instantaneous overcurrent trip output 2 (7IVD-J)	Trip of the current elements.
113	SUI_B2	Phase B instantaneous overcurrent trip output 2 (7IVD-J)	
114	SUI_C2	Phase C instantaneous overcurrent trip output 2 (7IVD-J)	
115	SUI_N2	Ground instantaneous overcurrent trip output 2 (7IVD-J)	
116	AUI_A2	Phase A instantaneous overcurrent pickup 2 (7IVD-J)	Pickup of the current elements unaffected by torque control.
117	AUI_B2	Phase B instantaneous overcurrent pickup 2 (7IVD-J	
118	AUI_C2	Phase C instantaneous overcurrent pickup 2 (7IVD-J)	
119	AUI_N2	Ground instantaneous overcurrent pickup 2 (7IVD-J)	
120	AIDD_A2	Phase A instantaneous torque-controlled overcurrent pickup 2 (7IVD-J)	AND logic of the pickup of the current elements with the corresponding torque-control input.
121	AIDD_B2	Phase B instantaneous torque-controlled overcurrent pickup 2 (7IVD-J)	
122	AIDD_B3	Phase C instantaneous torque-controlled overcurrent pickup 2 (7IVD-J)	
123	AIDD_N2	Ground instantaneous torque-controlled overcurrent pickup 2 (7IVD-J)	
124	SUIM_A2	Phase A instantaneous overcurrent mask enabled trip output 2 (7IVD-J)	They trip the elements affected by their corresponding trip mask.
125	SUIM_B2	Phase B instantaneous overcurrent mask enabled trip output 2 (7IVD-J)	
126	SUIM_C2	Phase C instantaneous overcurrent mask enabled trip output 2 (7IVD-J)	
127	SUIM_N2	Ground instantaneous overcurrent mask enabled trip output 2 (7IVD-J)	
117	T1_A	Group 1 active (7IVD-L)	
118	T2_A	Group 2 active (7IVD-L)	
119	T3_A	Group 3 active (7IVD-L)	
120	IDD_A	Phase A current in the trip direction (7IVD-K/L)	Current in the trip direction.
121	IDD_B	Phase B current in the trip direction (7IVD-K/L)	
122	IDD_C	Phase C current in the trip direction (7IVD-K/L)	
123	IDD_N	Ground current in the trip direction (7IVD-K/L)	
124	SUT_AD	Phase A directional time element output (7IVD-L)	Trip of the current elements.
125	SUT_BD	Phase B directional time element output (7IVD-L)	
126	SUT_CD	Phase C directional time element output (7IVD-L)	
127	SUT_ND	Ground directional time element output (7IVD-L)	
128	SUI_AD	Phase A directional inst. element output (7IVD-L)	
129	SUI_BD	Phase B directional inst. element output (7IVD-L)	
130	SUI_CD	Phase C directional inst. element output (7IVD-L)	
131	SUI_ND	Ground inst. element output (7IVD-L)	

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Table 6-4:Logic Output Signals			
No	**Name**	**Description**	**Function**
132	AUT_AD	Phase A directional time element pickup (7IVD-L)	Pickup of the current elements unaffected by torque control.
133	AUT_BD	Phase B directional time element pickup (7IVD-L)	
134	AUT_CD	Phase C directional time element pickup (7IVD-L)	
135	AUT_ND	Ground directional time element pickup (7IVD-L)	
136	AUI_AD	Phase A directional instantaneous element pickup (7IVD-L)	Pickup of the current elements unaffected by torque control.
137	AUI_BD	Phase B directional instantaneous element pickup (7IVD-L)	
138	AUI_CD	Phase C directional instantaneous element pickup (7IVD-L)	
139	AUI_ND	Ground instantaneous element pickup (7IVD-L)	
140	ATDD_AD	Phase A directional time element torque-controlled pickup (7IVD-L)	AND logic of the pickup of the current elements with the Corresponding torque-control input
141	ATDD_BD	Phase B directional time element torque-controlled pickup (7IVD-L)	
142	ATDD_CD	Phase C directional time element torque-controlled pickup (7IVD-L)	
143	ATDD_ND	Ground directional time element torque-controlled pickup (7IVD-L)	
144	AIDD_AD	Phase A directional instantaneous torque-controlled pickup (7IVD-L)	AND logic of the pickup of the current elements with the corresponding torque-control input
145	AIDD_dB	Phase B directional instantaneous torque-controlled pickup (7IVD-L)	
146	AIDD_CD	Phase C directional instantaneous torque-controlled pickup (7IVD-L)	
147	AIDD_ND	Ground directional time element torque-controlled pickup (7IVD-L)	
148	SUTM_AD	Phase A directional time element mask enabled output (7IVD-L)	They trip the elements affected by their corresponding trip mask.
149	SUTM_BD	Phase B directional time element mask enabled output (7IVD-L)	
150	SUTM_CD	Phase C directional time element mask enabled output (7IVD-L)	
151	SUTM_ND	Ground directional time element mask enabled output (7IVD-L)	
152	SUIM_AD	Phase A directional instantaneous overcurrent mask enabled trip output (7IVD-L)	
153	SUIM_BD	Phase B directional instantaneous overcurrent mask enabled trip output (7IVD-L)	
154	SUIM_CD	Phase C directional instantaneous overcurrent mask enabled trip output (7IVD-L)	
155	SUIM_ND	Ground directional instantaneous overcurrent mask enabled trip output (7IVD-L)	
156	UN_BLQ	Ground measuring elements lockout (7IVD-L)	This signal activates when all the ground measuring elements are simultaneously locked out.

You can use the ***ZIVercom***® software program to create and modify logic equations.

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- **Breaker trip and close outputs**

The protection subsystem has two switching output signals with two contacts each, generally open. One of these switching outputs is assigned to the logic output called **Open**. This output is activated when the relay generates a trip and when the breaker is opened manually. In both cases, it remains active at least 100 ms.

The second switching output signal is assigned to the **Close** logic output. This output is activated when the recloser function generates a reclose command and when the breaker is closed manually.

- **Switching commands on the breaker**

Open and close commands can be sent to the breaker through protection as well as with the open and close contacts. You can use the **Switching permissions** setting in the **Configuration** group of settings to disable the sending of these switching commands through protection. Manual operation is designed to require confirmation before switching commands are executed.

The IED is designed to confirm that the breaker has changed state. A breaker open and a breaker close failure time can be programmed for trip and close operations. **Open command failure** or **close command failure** alarms are generated if the breaker response is too slow.

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6.20.3 LED Targets

The logic output signals generated by protection can be inputs to each of the combinational logic gates as diagrammed in figure 6.28. The function is similar to the auxiliary contact outputs. One of the two blocks has eight inputs that perform an OR operation (any signal activates the output). The other block has one input. The two blocks together can perform an OR or an AND operation without the subsequent possibility of using pulses. The communications interface sends all twelve outputs to the control subsystem.

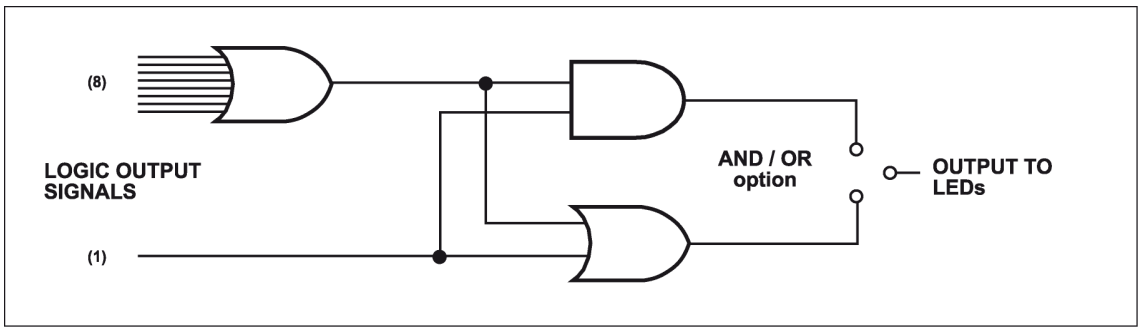

Figure 6.28: Block Diagram of the Logic Cell Associated to each of the Outputs that Act on the LEDs.

The IED has twelve outputs of this type and the first four LEDs are physically visible.

Each LED can be latched or unlatched. If an LED is latched, it will remain illuminated until reset. You can use the **F2** key (see Chapter 8, Alphanumeric Keypad and Display) to send a reset order to the latched LEDs.

The latching function resides in the volatile memory section of the microprocessor. A power supply loss will cause any latched LED to reset.

You can associate the LEDs to any of the available logic output signals indicated in table 6-4. You can use the ***ZIVercom***® software program to create and modify logic equations.

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6.21 Communications

6.21.1 Communications Settings

Chapter 5 (settings) explains the communications settings in detail and provides information about the **IED address**, **Baud rate**, **Stop bits, Parity of the rear port** and **Parity of the front port**. Other settings will be included when the communications protocol used (for example, DNP3.0) requires them.

6.21.2 Communications Types

7IVD IEDs have two types of communication ports: always one RS232C type on the front, and an optional port on the back. For the latter, you can choose between 1-mm glass or plastic optical fiber, RS232C and RS485. The technical data about these communication links are in Chapter 2 (Technical characteristics).

You can also have a second rear port for remote communications with protection, but you can not configure digital inputs or outputs in this second rear port. The IED gives priority to the front port over the rear port.

6.21.3 Communicating with the 7IVD

To communicate through these ports, use the ***ZIVercom***® communications program, which interrogates the IED's protection profile. The ***ZIVercom***® program dialogs with the **7IVD** family and other equipment, either **locally** (through a PC connected to the front port) or **remotely** (via the rear communications port) about all programming, settings, event recording, reports, etc. The ***ZIVercom***® communications program, which covers the protection profile, is password-protected against unauthorized users. The ***ZIVercom***®, which runs under **Windows**™, is user-friendly. You use buttons or keys to open the various submenus.

Use the **PROCOME** or **DNP 3.0** profile to communicate with the IED to request control changes and to execute orders.

You can configure the remote communication ports only through the HMI. Note that the setting for the front port is fixed at 4,800 bauds and 1 stop bit but you can select the parity in the devices with rear port remote communications with protection as already indicated in Chapter 5.

7IVD models have two controllers, one for each remote communication port, so that you can establish communication through both ports at the same time.

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6.22 Alarm Codes

The following table lists the protection alarm codes and their description. View these codes in the IED's display.

Software alarms - protection -

Code	Description
01 00	Loss of settings
04 00	Check-sum of the RAM area for the curves
08 00	CIM communication failure with the control subsystem
80 00	Protection out of service

Hardware alarms - protection -

Code	Description
00 01	E2PROM writing error
00 02	Critical error in the analog-digital converters
00 04	Fatal error in the analog-digital converters
00 06	Error in the internal voltage levels
00 08	Low clock battery
00 10	Clock not running
00 20	Error in the E2PROM manufacturer identification file
00 40	Error in the RAM manufacturer identification file
00 80	Memory test error

Software alarms - control -

Code	Description
01 00	Loss of settings
00 40	Error in the single-wire diagram of the configuration of control
00 80	Error in the control logic
10 00	Alarm in the logic addresses
20 00	Alarm in the logic opcodes
40 00	CIM communication failure with the protection subsystem
80 00	CIM communication failure with the metering circuit board

Hardware alarms - control -

Code	Description
00 01	E2PROM writing error
00 02	Critical error in the analog-digital converters
00 04	Fatal error in the analog-digital converters
00 08	Low clock battery
00 10	Clock not running
00 20	Error in the IED's input and/or output converters

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If more than one alarm occurs at the same time, the hexadecimal codes are added as shown in the examples below.

01 and 02 = 03
01 and 04 = 05
02 and 08 = 0A
01 and 02 and 08 = 0B
04 and 08 = 0C
01 and 04 and 08 = 0D
02 and 04 and 08 = 0E
01 and 02 and 04 and 08 = 0F

Warning: contact the manufacturer if the IED displays any of these alarms codes.

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7. Description of the Operation of the Control Subsystem

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7.1 Operational Characteristics

The IEDs can execute local programmable control functions associated with the bay as well as the logic associated with internal and external interlockings, treatment and generation of alarms and processing of signals, and have programmable logic.

The execution of interlockings towards the external circuits implies being able to execute continuously active outputs depending on the combination of the state of various input signals through logic gates. These interlocking outputs are used for interrupting / continuing an exterior command circuit. These interlockings are the consequence of the logic capacity pointed out in the following sections.

The execution of internal interlockings implies being able to obtain logic outputs of permission / lockout of commands towards the external circuits according to the combination of the state of various input signals through logic gates. These processed logic signals affect the permissions / lockouts of commands generated both from the unit's local control module and from the central unit originating in the control display, central programmable control functions and/or remote control.

Logical alarms can be generated with data from the combination of the state of various input signals through logic gates as well as from "timers" of presence / absence of a given signal, either physical or logic.

The processing of analog signals offers the possibility of comparing analog inputs with set points and of generating digital ON/OFF signals as a result of this comparison as well as the possibility of adding and multiplying analog signals.

The control functions are the following:

- Local / remote control of the bay
- Local / remote recloser control
- Local control of the ground measurement elements (**7IVD-L**)
- Local control of the active protection group (**7IVD-L**)
- Presentation of local alarms in conventional alarm panel format
- Presentation of the digital states of the output signals from the control subsystem
- Presentation of the digital states of the input signals of the control subsystem
- Presentation of the states of the protection outputs
- Presentation of the states of the protection LEDs
- Presentation of measurements and counters

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7.2 Control Subsystem

Figure 7.1 is the block diagram of the control unit. The control and protection subsystems are separated by a double line indicating that, although both subsystems are interconnected, they perform independent functions. The only connection between them is a communication path for information exchange. Note the following points in the diagram (referring to the control subsystem, central part of the figure):

- All single-line edged blocks contain the same type of signals.
- All thick-line blocks contain control subsystem elements. These elements receive and/or send signals to the exterior or to other elements of the control or protection subsystems. If the blocks have rounded corners, they represent control subsystem elements used to collect signals from other devices.
- Shaded blocks are externally configurable elements of the control subsystem.

The control process module is an additional module independent from the protection subsystem. It receives signals through various routes, processes them and, depending on the input signals and on the outcome of the process, generates output signals that are subsequently used for information, operations, alarms, etc. The signals that function as inputs to the control subsystem are treated according to a logic loaded as a file through the front remote communication port. It includes a number of settings that can be modified via the keypad associated with the alphanumeric display.

- **Processing the signals**

The control subsystem basically takes input signals from various sources, both external to the IED (communications or HMI) and internal, processes these signals according to the configuration that has been loaded and the pre-established settings and activates certain output signals that will be used for sending information messages or measurements to the central unit as well as commands to relays, LEDs and protection. You can view the state of the elements of the monitored bay, the alarms registered, the measurements, the counters and the status of the protection inputs, outputs and LEDs on the graphic display.

The **Logic** and the **Configuration** are especially important in the processing of the signals within the control subsystem. The logic has a set of *blocks* that encompass a series of logic operations. Each of these blocks determines an *outcome* (state of one or more signals) depending on the state of the inputs of that *block*. The **Configuration** determines the use of one or another *block*.

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The operation chosen to obtain a given output determines the input signals to the *blocks*. The **input connection process** is the software process that connects the inputs of the *blocks* with the appropriate inputs to the control subsystem according to the **configuration**.

Likewise, the output signals from the *blocks* are associated with output signals from the control subsystem. This is done in the **Output Connecting Process** according to the **Configuration**.

The required input signals to the control subsystem arriving via communications are coded according to PROCOME or DNP3 communications protocol, which requires each PROCOME / DNP3 index (coded signal) to be associated with its corresponding signal. This process is performed in **Input Tagging** and the associations are made in one form or another according to the **Configuration**. The same happens with the signals that are sent from the control subsystem via communications. The software process is carried out in **Output Tagging** and is also determined by the **Configuration**

- **Protection and control interconnection**

The control and protection subsystems are interconnected by sending signals to each other. The signals that protection sends to control are analog measurements (unless there is a metering circuit board), protection auxiliary contact outputs and the state of the protection LEDs.

Signals from protection to control are exchanged as indicated in Chapter 6, through a communications interface that picks up the fourteen protection auxiliary contact outputs and the twelve additional ones related to the visual signals. This same interface manages the joint use of the alphanumeric display by the two subsystems as described in Chapter 8, Alphanumeric keyboard and display.

- **Inputs / outputs from the control subsystem**

The input as well as the output signals depend on the configuration loaded in the IED. The number of these physical signals depends on the specific model.

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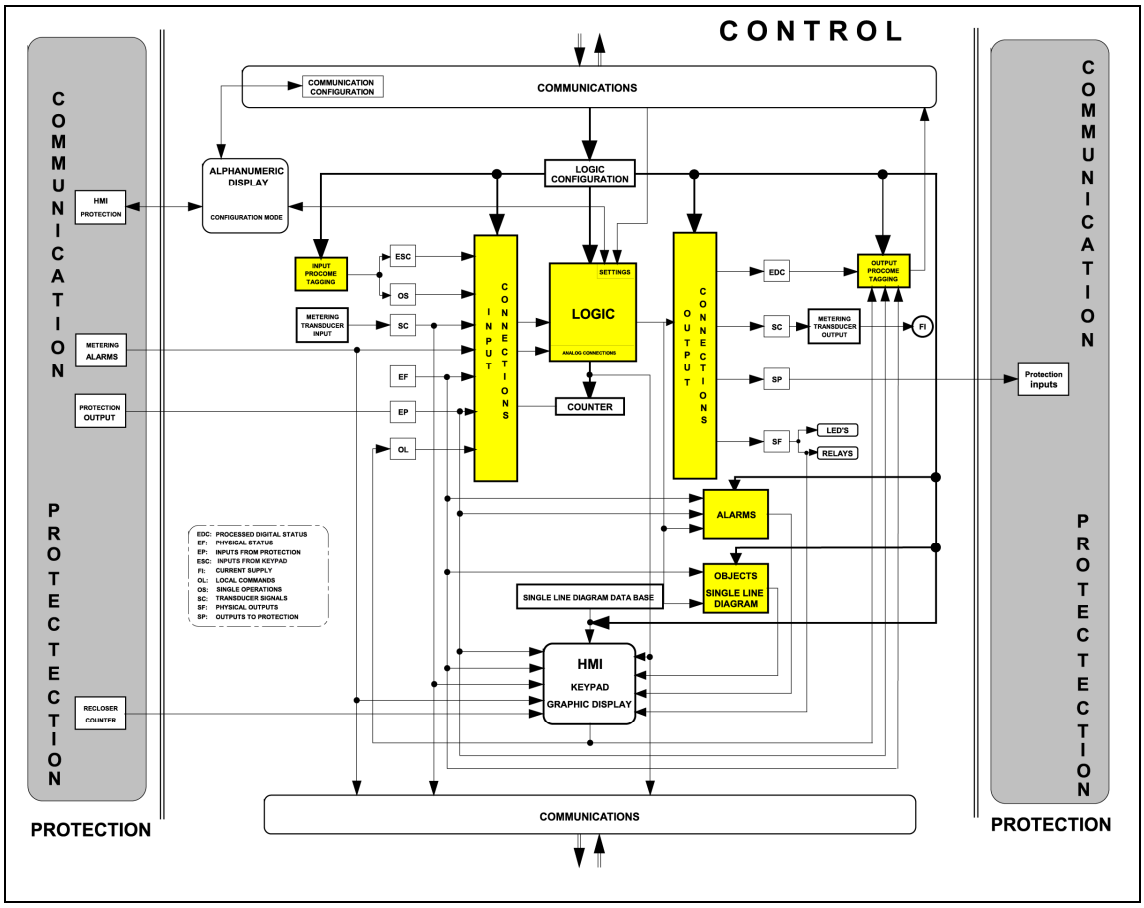

Figure 7.1: Block Diagram of the Control Subsystem.

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7.2.1 Elements of the Control Subsystem

- **Logic**

The **Logic** can be thought of as a processor containing a number of blocks. Each block performs a specific function based on the logic design. The processor uses external signals from the protection subsystem and from previously processed blocks. Each block generates one or more logic outputs that will be connected to a specific control subsystem output.

- **Counter**

Counters are logic elements designed to count the changes of state of a physical input. The accumulated value is presented on the graphic *display* and metering screen. You can also use the communications protocol to send the value to the central unit. The most common application is to accumulate pulses from the substation power meters.

- **Logic configuration**

Logic configuration is the software program downloaded to the IED via the local or remote communication port. Some of the program features are described below:

- Association of the control subsystem inputs to the logic inputs.
- Association of the control subsystem outputs to the logic outputs.
- Association of logic outputs and specific PROCOME / DNP3 indexes to send these signals via communications to other devices.
- Association of the incoming communication signals (via the communication port) and their specific PROCOME / DNP3 index to related logic inputs within the control subsystem.
- Association of logic outputs and their specific output signals (via communication port) related to a PROCOME / DNP3 index.
- The use of a specific block group whose inputs and outputs are defined by the configuration.
- The use of alarm input signals, physical input signals, protection inputs and logic outputs.
- Association of input signals to the single-line diagram elements, physical input signals and logic outputs.
- The use of one or another single-line diagram depending on the model and on the tags associated with each of the single-line diagram elements.
- In the **7IVD-L** model, the logic configuration compilation mode defines the language in which all the menus and messages are presented in the alphanumeric and graphic displays. Options are: Spanish, English and Portuguese

- **Communication**

Use this function to install the IED logic configuration, send operation commands to the control subsystem and load logic settings. You can also use it to communicate with a central unit processor.

- **Alarm Group**

The **Alarm Group** is an alarm processor that receives signals from the protection subsystem, physical inputs and logic outputs. Alarms will be shown on the graphic display when appropriate.

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- **Single-Line diagram elements**

They comprise the general graphic representation of the installation protected by the unit. The set of **Single-Line diagram elements** contains all the data necessary to relate each logic symbol configured in the single-line logic within the logic configuration. These elements contain information about input signals (state of the single-line diagram elements) and orders associated with each element sent from the graphic HMI.

- **Input metering transducer**

The **Input Transducer** is an interface element between an external DC current signal and the control subsystem. The metering unit and the conversion constant settings are configurable and can be modified using the alphanumeric display in **Control** mode, **General Settings** modification menu.

- **Output metering transducer**

Input signals, output signals, connection processes and signal tagging are associated with the previously described elements. They are divided into four groups:

Input connection: input signals (to be processed in the logic).
Output connection: logic output connection to enable signals to be sent to other elements within the same IED.
Output tagging: identification of signals to be sent to the central unit.
Input tagging: identification of incoming signals that will be processed by the relay's internal logic.

7.2.2 Control Unit Input Data

Depending on the data input sources, incoming data to the control subsystem can be grouped as signals entering via the **Communications Port**, **Protection Subsystem** inputs, **Physical** inputs and HMI inputs.

7.2.2.a Communication Inputs

The inputs that arrive through communications go through the software process called **input tagging**, which decodes the PROCOME / DNP3 communications protocol and classifies the signals as output writing signals (**ES**) and simple commands (**OS**). The simple commands can be console commands (**OC**), telecommanded commands (**OT**) or automatism commands (**OA**).

- **Writing signals and simple commands**

A **writing output signal** through communications permits modifying the output status or indication on the graphic display; for example, the voltage indication. **Console commands** are received from the central unit console. **Telecommanded commands** also come from the central unit but originate in the remote operation desk. **Automatism commands** are commands generated by control logic residing in the central unit.

Writing input signals as well as simple commands, once decoded, must be tagged (connected) to be processed by the logic. This is performed by another software process called **input connection**. This association of signals as well as the decoding of the PROCOME / DNP3 code depends on the IED's configuration. Once these signals are tagged, the logic will determine how and where they will be used.

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7.2.2.b Protection Subsystem Inputs

The signals entering the control subsystem from protection are: protection **input signals**, **AC measures** made by protection and **reclosing attempt records**.

- **Protection states**

The input signals from protection (**EP**) used by control are determined by the IED configuration and can be protection auxiliary contact outputs and trip outputs as well as protection **LEDs**. These signals, after **output tagging**, can be sent out of the IED through communications shown in the display, sent to the **alarm panel** and be used by the **logic**.

- **Metering**

AC metering values (**V, I, P, Q,...** depending on the model and its configuration) are sent directly via communications to the central unit. The values are shown on a specific screen on the graphic display (see Chapter 9). The logic can also use these values. The analog values are generally used to activate alarms or outputs when a threshold setting is exceeded. If the IED has a metering circuit board, these values sent from protection will not appear. Instead, the metering circuit board will capture and send the values to control.

- **Reclosure attempts counter**

The reclosure attempts counter does not go through the logic. Instead its signals are shown directly on the graphic display.

7.2.2.c Physical Inputs

All the physical inputs can be sent via the communications port (after **output tagging**) or they can used by the logic (if identified by the **input connection**). These signals are also directly shown on the graphic display. Physical inputs can be of two types:

- **Contact transducer inputs**. These are called **EF** in figure 7.1. As well as the features mentioned above, these signals can be connected to the alarm and/or to the single-line diagram elements.
- **Metering transducer inputs**. The signals called **SC** are connected to the metering transducers in the control subsystem.

7.2.2.d Inputs via the Human-Machine Interface (Control HMI)

These signals are commands on single-line diagram elements sent directly by the **O**, **I** or **DES** keys from the control HMI after determining the corresponding element with the selection key **SEL**.

These signals are subjected to the interlockings defined in the logic before being executed. If the logic state is such that these commands cannot be executed, a "non-executed command" message will be displayed on the HMI.

Local Commands are also sent to the central unit to differentiate whether a change of state has occurred automatically or has been manually performed. After output tagging in the **Output Connection**, these signals are sent via the communication port.

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7.2.3 Data Output from the Control Subsystem

Based on the possible output paths, the control subsystem outputs can be classified as: **communication outputs**, **outputs sent to the protection subsystem**, **physical outputs** and **outputs to the HMI**.

7.2.3.a Communication Outputs

These signals are sent to the central unit via the remote communications port located on the rear panel of the IED. These signals can be:

- **Measures**. Signals collected in the protection subsystem or by the metering circuit board and those coming from the **input metering transducers** can be sent to the central unit. These signals are not tagged but sent sequentially. The application in the central unit assigns them specific values.
- **Counters**. Outcome signals from the logic processing of input signals picked up through the **input connection** are accumulated in the counter. These counter values are sent directly to the central unit without tagging.
- **Logical states**. The logical states sent to the central unit can be logic signals such as the calculated digital states (**EDC**) or direct control subsystem inputs, such as the physical inputs of contact transducers (**EF**), protection inputs (**EP**) and local commands (**OL**). After **output tagging**, they are all sent via the communications port.

7.2.3.b Signals Sent to the Protection Subsystem

The signals sent to the protection subsystem are outputs of the control logic assigned by the **output connection system**. The signals (**SP**) are assigned as follows:

Table 7-1: Signals Sent to the Protection Subsystem

Command	Signal towards protection
Recloser blocked	SP0
Recloser lockout reset	SP1
Reset of the distance sent by communications	SP2 (only 7IVD-L8N)
Activation group 1	SP3 (only 7IVD-L8N)
Activation group 2	SP4 (only 7IVD-L8N)
Activation group 3	SP5 (only 7IVD-L8N)
Block reclosing of ground measuring elements	SP6 (only 7IVD-L8N)
Unblocking of ground measuring elements	SP7 (only 7IVD-L8N)

7.2.3.c Physical Outputs

Physical outputs are output signals from the logic and determined by the **output connection system**. The signals can be of two types: physical outputs from contact converters (**SF**) and outputs from metering converters (**mA**)

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7.2.3.d Outputs to the Human-Machine Interface (HMI Control Subsystem)

The **output to the human-machine interface** signals are accessible through the screens of the graphic display:

- **States of the elements**

The logical states of the elements displayed are those states stored in the **single-line diagram elements**. The state is determined by output signals from the **logic** and physical inputs (**EF**) to the control subsystem. Changes in the state of the elements are shown in the single-line diagram on the display.

- **Alarms**

The **alarms** represented on the graphic display are messages sent from the **alarm system**. They are derived from the logic signals, physical inputs to the subsystem and input signals received from protection.

- **Metering values**

The metering values shown on the graphic display are those sent by protection: the measures of the **input transducers** and the values stored in the **counters** (the **reclosure counter** received directly from protection and the output signal from the **counter** element).

- **Contact input status**

These signals represented on the **digital inputs** display indicate the state (active / not active) of the inputs to the control subsystem.

- **Contact output status**

These signals represented on the **digital outputs** display indicate the state (active / not active) of the physical outputs from the contact transducers (**SF**) of the control subsystem.

- **Protection LEDs status**

Another screen displays the status (**ON** - **OFF**) of the protection subsystem LEDs accessible through the protection input signals (**EP**).

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8. Alphanumeric Keypad and Display

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8.1 Alphanumeric Keypad and Display

The liquid crystal alphanumeric display has a 4-row by 20-character matrix. It displays information about IED alarms, settings, metering, states, etc. There are 4 function keys (**F1**, **F2**, **F3** and **F4**) under the display. The next section explains their functions. Figure 8.1 shows the default graphic display and the function keys.

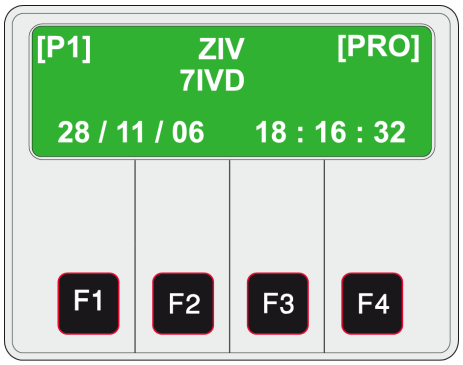

Figure 8.1: Alphanumeric Display and Function Keys.

- **Default display**

As you can see in figure 8.1, the default *display* shows the IED model, the date and the time. The upper left corner also indicates the connection mode—if communication has been established (*****):

[P1] Local connection (communication through the front port)
[P2] Remote connection (communication through the rear port)

The upper right corner indicates which of the two operation modes the IED is in.

[PRO] Protection
[CON] Control

(*) only when the display is in protection mode

- **Alphanumeric keypad**

The keypad consists of 16 keys arranged in a 4 x 4 matrix. Their properties are specified next. Figure 8.2 shows the layout of this keypad.

In addition to the digit keys (0 to 9), there are two selection keys (↑ and ↓), a confirmation key (**ENT**) and an escape key (**ESC**).

There are two different ways for you to execute the functions of models **7IVD-J, 7IVD-K and 7IVD-L** from the default screen: using one single key (**F2**) or using the whole keypad.

Figure 8.2:Keypad Layout.

Use the digit keys to input new numerical settings. Use keys **1** and **0** to input **YES** and **NO** settings respectively.

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8.2 Keys, Functions and Operation Modes

This section explains the alphanumeric display's function keys and the keypad's digit keys.

- **Keypad**

Confirmation key

Use the **ENT** key to confirm an action after making a selection or after editing a setting and to advance to view all the records. After any operation (selection, change of settings, information, etc.), press **ENT** again to access the immediately preceding level.

Escape key

The **ESC** key is used to exit a screen if you do not want to change a setting or simply to exit an information screen. In any case, press this key to return to the immediately preceding screen.

Display selection keys

The selection keys are for advancing or returning, in correlative order, to any of the options of a menu or a submenu. When a menu has more than four options, an arrow (↓) will appear in the lower right corner of the display indicating that there are more.

Use the ↓ key to view the second set of options. An arrow (↑) will appear in the upper right corner of the display to indicate the existence of the first set of options.

Default display key

Press this key from any menu or submenu to return directly to the default display.

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- **Function keys**

F1

Press **F1** to confirm changes in settings (when the IED requests such confirmation) and to confirm the activation of a settings group (when the IED requests this confirmation).

F2

When the IED is in protection mode [**PRO**], press **F2** to view the measurements of current, voltage, power and frequency (line-to-neutral voltages, phase-to-phase voltages and energy sources in **7IVD-L**), to block / unblock the recloser function, to reset the last trip indication and to reset LEDs and the reclose counter. This whole sequence of **F2** functions is explained in the next section.

F3

Press **F3** to toggle between the protection **[PRO]** and control **[CON]** subsystems. From the event record screen, use the **F3** key to view the succession of octets that contain the codes of the function that has generated the relevant event.

F4

Press the **F4** key to reject changes in settings (when the IED requests confirmation of the changes) and to reject the activation of a reserve settings group (likewise when such confirmation is requested). You can also use **F4** to activate some of the IED's internal functions, each with a different factory-defined password.

In the fault report screens, use **F4** to access the information about the element initiating the trip and elements tripped during the fault.

- **Accessing the options**

Use the digit keys (0 to 9) to **directly access** the various options (settings, data, measurements, etc.) that are presented in the following sections. This direct access consists in successively pressing the identification numbers that the screen displays prior to each setting or option within the corresponding setting.

Another way to access the options consists in navigating the menus with the selection keys (↓↑) and then confirming the option selected with **ENT**.

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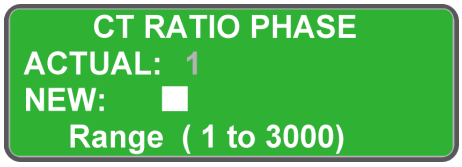
- **Operation**

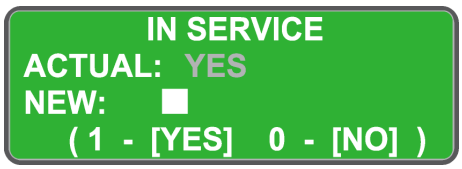
Change of settings (range)

The change of settings (range) presents the following arrangement: the operational value of the setting appears in the place indicated by the word **ACTUAL**. Enter the new value where you see a blinking cursor in the next line indicated by the word **NEW**.

Use the digit keys to edit the new value, which must agree with the range specified in the last line of the display. If an error occurs upon inputting a value, use the ↓ key to erase it. Once you have edited the new value, press **ENT** to confirm and exit to the preceding menu.



There is a type of setting that follows this outline but with a range limited to the options, **YES** and **NO**. In this case, the **1** and **0** keys correspond to the values **YES** and **NO**. Then press **ENT** to confirm the setting and return to the preceding screen.



Change of settings (options)

These settings are presented in an options menu which you select by either of two already known procedures: with the direct access number associated with the option or by using the keys ↓ and ↑ and confirming with **ENT**. In both cases, the system returns to the preceding screen once you have made the selection.

- **Exiting menus and settings**

To exit a menu or a setting without changing it, press the **ESC** key. To exit an information screen, press either **ENT** or **ESC** indistinctly. In both cases, you return to the preceding menu.

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8.3 Accessing the Protection Functions with a Single Key (F2)

The protection functions are accessible with a single key, **F2**, from the default screen or from the information screen of the last trip (always with the *display* indicating protection mode [PRO]). Pressing **F2** then will display the information in a rounded rectangle window in which you can view and execute the following maneuvers:

- Measurements of the phase/ground and angle currents
- Measurements of the phase and angle voltages
- Measurements of active and reactive powers and the power factor
- Measurement of frequency
- Possibility of blocking/unblocking the recloser function
- Resetting of the last trip indication
- Resetting LEDs
- Resetting the reclose counter

In model **7IVD-L**, the information sequence is the following:

- Measurements of the phase and ground currents with their arguments
- Measurements of the line-to-neutral voltages with their arguments
- Measurements of the phase-to-phase voltages
- Measurements of powers and power factor
- Measurements of energies
- Measurement of frequency
- Information about the recloser state and its lockout / unlock
- Resetting of the last trip indication
- Resetting LEDs
- Resetting the reclose counter

8.3.1 Last trip indication

If there has been a trip, the IED will present its data first. This information is presented as follows:

T means **TRIP** and the following elements indicates which elements initiated the last trip. If only one type of element (instantaneous, time, residual current or open phase) is involved, only the first line will be used.

If two types of elements (instantaneous and time) are involved, both lines will be used. Voltage and frequency elements appear in the third line. If there have been no trips since the last reset, this screen is not presented.

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Instantaneous trip:

Model 7IVD-L: INS_XXXX
XXXX is replaced by the phases and ground that have generated the trip. For example, in a trip due to a two-phase-to-earth fault (phases A and B) by an instantaneous element, **INS_ABN** will be displayed.

Model 7IVD-J: I1_ XXXX / I2_ XXXX
I1 refers to instantaneous element 1, while **I2** corresponds to instantaneous element 2**. XXXX** is replaced by the phases and ground that have generated the trip.

Directional instantaneous trip

Model 7IVD-L: ID_XXXX
XXXX is replaced by the phases and ground that have generated the trip. For example, in a trip due to a two-phase-to-earth fault (phases A and B) by a directional instantaneous element, **ID_ABN** will be displayed.

Time trip: TEM_XXXX

XXXX is replaced by the phases and ground that have generated the trip. For example, in a trip due to a single-phase-to-ground fault (phase A) by a time element, **TEM_AN** will be displayed.

Directional time trip

Model 7IVD-L: TD_XXXX
XXXX is replaced by the phases and ground that have generated the trip. For example, in a trip due to a single-phase-to-ground fault (phases A) by a directional time element, **TD_AN** will be displayed.

Trip by overvoltage: SOT_XXX

XXX is replaced by the phases that have generated the trip.

Trip by undervoltage: SUT_XXX

XXX is replaced by the phases that have generated the trip.

Trip by frequency elements: F_XX

XX is replaced by the elements (1 and/or 2) that have generated the trip.

Trip by open phase: TEM_F

Trip by residual current: TEM_R

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- **Recloser**

The last line indicates the status of the recloser function: **BLOCKED**, if it is blocked manually or externally (**BLQ** the recloser active signal); **UNBLOCKED**, if it is unblocked (**BLQ** and **BI** the recloser inactive signals); **INTERNAL BLQ**, if it is internally blocked (**BI** the recloser active signal).

The number of reclose attempts accumulated since the last reset completes the information about the recloser function. The number of first reclose attempts is in the first block and the number of accumulated remaining reclose attempts is in the second block.

- **Metering**

In the default situation or from the information screen of the last trip, navigate through the metering screens in order by pressing the **F2** function key. The first screen gives the primary values of the **phase** and **ground currents**. The phase A voltage **angle** appears after each of the values.

The second metering screen shows the **voltage of the phases**. The third and last screen presents the **frequency**.

In model **7IVD-L**, the metering sequence is the following: **phase and ground currents** with their **arguments**, **line-to-neutral voltages** with their **arguments**, **phase-to-phase voltages**, **powers** and **power factor**, **energies** and **frequency**.

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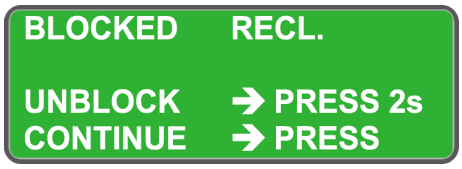
- **Recloser state**

The first row is the current state of the recloser (**BLOCKED**, **UNBLOCKED** or **OUT OF SERVICE**). The second row queries the maneuver to be performed (**UNBLOCK or BLOCK**). If the first row message is **OUT OF SERVICE**, there is no status change query.

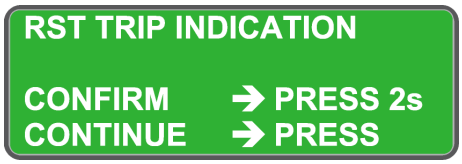


If you do not want to change the status of the recloser function, press continue (**F2**) to move on to the **resetting the trip indication screen.** If you do want to change its status, hold it down for 2 seconds to execute the order indicating **COMMAND SENT TO RECLOSER**.

- **Resetting the trip indication**

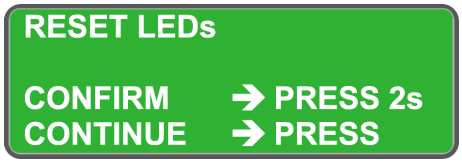
If you press **F2** again, you get the following screen for resetting the trip indication.

If you do not want to reset the indication, press **F2** to continue. This takes you to the screen for resetting LEDs. Otherwise, hold it down for 2 seconds to execute the command. The screen will show the confirmation: **INDICATION RESET**



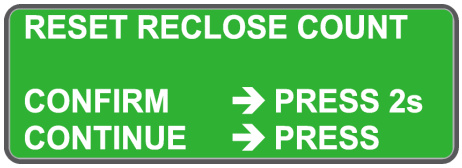
- **Resetting LEDs**

If you press **F2** again, you get the screen for resetting **LEDs**. If you do not want to reset the signal, press continue (**F2**) to access the screen for resetting the reclose counter. If you hold it down for 2 seconds, the order is executed and the LEDs light up. The screen displays **LEDs ACTIVATED**.



- **Resetting the reclose counter**

If press **F2** again, you get the screen for resetting the reclose counter. The treatment of this screen is the same as above. If you perform the reset, you see **RECL COUNTER RESET**.



Pressing F2 again from this last screen returns you to the default screen. From there, you can start the cycle over. If, on any screen, you do not press the key during more than twenty seconds, the system will automatically return to the default screen without executing any of the maneuvers described above.

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8.4 Function Access Using the Keypad

From the default screen or the trip / reclose screen, pressing any key on the keypad displays the Main Menu. The main menu has a series of sub-menus associated with it. The following tables present a sequence example.

- **Configuration Settings: HMI Access**

0 - CONFIGURATION	**0 - PASSWORDS**
1 - OPERATIONS	**1 - OPERATION ENABLE**
2 - ACTIVE GROUP	**2 - CONFIGURE INPUTS**
3 - CHANGE SETTINGS	**3 - CONFIGURE OUTPUTS**
4 - INFORMATION	**4 - PHASE SEQUENCE (*)**
	5 -LANGUAGE
	6 - NOMINAL FREQUENCY (*)

0 - CONFIGURATION	**0 - PASSWORDS**	**0 - CONFIGURATION**
1 - OPERATIONS	1 - OPERATION ENABLE	**1 - OPERATIONS**
2 - ACTIVE GROUP	2 - CONFIGURE INPUTS	**2 - SETTINGS**
3 - CHANGE SETTINGS	3 - CONFIGURE OUTPUTS	
4 - INFORMATION	4 - PHASE SEQUENCE (*)	
	5 -LANGUAGE	
	6 - NOMINAL FREQUENCY (*)	

0 - CONFIGURATION	0 - PASSWORDS	**0 - BREAKER**
1 - OPERATIONS	**1 - OPERATION ENABLE**	**1 - RECLOSER**
2 - ACTIVE GROUP	2 - CONFIGURE INPUTS	**2 - REMOTE SETTINGS**
3 - CHANGE SETTINGS	3 - CONFIGURE OUTPUTS	**3 - BLOCK/RESET GND E. (*)**
4 - INFORMATION	4 - PHASE SEQUENCE (*)	
	5 -LANGUAGE	
	6 - NOMINAL FREQUENCY (*)	

0 - CONFIGURATION	0 - PASSWORDS	
1 - OPERATIONS	1 - OPERATION ENABLE	
2 - ACTIVE GROUP	2 - CONFIGURE INPUTS	
3 - CHANGE SETTINGS	3 - CONFIGURE OUTPUTS	**1 - SPANISH**
4 - INFORMATION	4 - PHASE SEQUENCE (*)	**2 - ENGLISH**
	5 - LANGUAGE	**3 - PORTUGUESE**
	6 - NOMINAL FREQUENCY (*)	

(*) 7IVD-L Model.

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- **Operations: HMI Access**

0 - CONFIGURATION	**0 - BREAKER**
1 - OPERATIONS	**1 - RECLOSER**
2 - ACTIVE GROUP	**2 - BLOCK/RESET GND E. (*)**
3 - CHANGE SETTINGS	
4 - INFORMATION	

(*) 7IVD-L Model.

- **Active Group: HMI Access**

0 - CONFIGURATION	**0 - GROUP 1 (ACTIVE)**
1 - OPERATIONS	**1 - GROUP 2 (RESERVE)**
2 - ACTIVE GROUP	**2 - GROUP 3 (RESERVE)**
3 - CHANGE SETTINGS	
4 - INFORMATION	

- **Change Settings: HMI Access**

0 - CONFIGURATION	**0 - GENERAL**
1 - OPERATIONS	**1 - CURRENT**
2 - ACTIVE GROUP	**2 - VOLTAGE**
3 - CHANGE SETTINGS	**3 - RECLOSER**
4 - INFORMATION	**4 - LOGIC**
	5 - BREAKER SUPV
	6 - HISTORICAL RECORD
	7 - OSCILLOGRAPHY (*)

(*) Optional.

General Settings: HMI Access

0 - CONFIGURATION	**0 - GENERAL**	**0 - IN SERVICE**
1 - OPERATIONS	1 - CURRENT	**1 - CT RATIO PHASE**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - CT RATIO GROUND**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - VT RATIO**
4 - INFORMATION	4 - LOGIC	**4 - OPEN BREAKER STAT**
	5 - BREAKER SUPV	
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

(*) Optional.

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Current Settings: HMI Access

7IVD-J

0 - CONFIGURATION	0 - GENERAL	**0 - PH TIME O/C**
1 - OPERATIONS	**1 - CURRENT**	**1 - GR TIME O/C**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - PH 1 INSTANTANEOUS**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - PH 2 INSTANTANEOUS**
4 - INFORMATION	4 - LOGIC	**4 - GR 1 INSTANTANEOUS**
	5 - BREAKER SUPV	**5 - GR 2 INSTANTANEOUS**
	6 - HISTORICAL RECORD	**6 - SUSTAINED GROUND**
	7 - OSCILLOGRAPHY (*)	**7 - PHASE UNBALANCE**
		8 - BREAKER FAILURE

7IVD-K

0 - CONFIGURATION	0 - GENERAL	**0 - PH TIME O/C**
1 - OPERATIONS	**1 - CURRENT**	**1 - GR TIME O/C**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - PH INSTANTANEOUS**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - GR INSTANTANEOUS**
4 - INFORMATION	4 - LOGIC	**4 - SUSTAINED GROUND**
	5 - BREAKER SUPV	**5 - PHASE UNBALANCE**
	6 - HISTORICAL RECORD	**6 - BREAKER FAILURE**
	7 - OSCILLOGRAPHY (*)	

7IVD-L

0 - CONFIGURATION	0 - GENERAL	**0 - PH TIME O/C**
1 - OPERATIONS	**1 - CURRENT**	**1 - GR TIME O/C**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - PH INSTANTANEOUS**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - GR INSTANTANEOUS**
4 - INFORMATION	4 - LOGIC	**4 - PH TIME DIR O/C**
	5 - BREAKER SUPV	**5 - GR TIME DIR O/C**
	6 - HISTORICAL RECORD	**6 - PH INSTANTANEOUS**
	7 - OSCILLOGRAPHY (*)	**7 - GR INSTANTANEOUS**
		8 - DIRECTIONAL UNIT
		9 - SUSTAINED GROUND
		10 - PHASE UNBALANCE
		11 - BREAKER FAILURE

(*) Optional.

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Voltage Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	**0 - OVERVOLTAGE**
1 - OPERATIONS	1 - CURRENT	**1 - UNDERVOLTAGE**
2 - ACTIVE GROUP	**2 - VOLTAGE**	**2 - FREQUENCY**
3 - CHANGE SETTINGS	3 - RECLOSER	
4 - INFORMATION	4 - LOGIC	
	5 - BREAKER SUPV	
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

(*) Optional.

0 - GENERAL	**0 - OVERVOLTAGE**	**0 - ENABLE UNIT**
1 - CURRENT	1 - UNDERVOLTAGE	**1 - OVERVOLT PICKUP**
2 - VOLTAGE	2 - FREQUENCY	**2 - OVERVOLT TIME**
..		**3 - TYPE OPERATION**

0 - GENERAL	0 - OVERVOLTAGE	**0 - ENABLE UNIT**
1 - CURRENT	**1 - UNDERVOLTAGE**	**1 - UNDERVOLT PICKUP**
2 - VOLTAGE	2 - FREQUENCY	**2 - UNDERVOLT TIME**
..		**3 - TYPE OPERATION**

0 - GENERAL	0 - OVERVOLTAGE	**0 - ENABLE UNIT**
1 - CURRENT	1 - UNDERVOLTAGE	**1 - FREQUENCY UNIT 1**
2 - VOLTAGE	**2 - FREQUENCY**	**2 - MAXMIN FREQ UNIT 1**
..		**3 - TIME SET. UNIT 1**
		4 - FREQUENCY UNIT 2
		5 - MAXMIN FREQ UNIT 2
		6 - TIME SET. UNIT 2
		7 - MIN VOLT. DISABLE

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Recloser Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	**0 - RECL. IN SERVICE**
1 - OPERATIONS	1 - CURRENT	**1 - RECLOSER TIMERS**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - SEQNCE CNTL TIMERS**
3 - CHANGE SETTINGS	**3 - RECLOSER**	**3 - SEQNCE CNTL**
4 - INFORMATION	4 - LOGIC	**4 - TRIP ENABLE**
	5 - BREAKER SUPV	**5 - RECLOSER ENABLE**
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

0 - GENERAL	0 - RECL. IN SERVICE	**0 - RECL_1 PH TIME**
1 - CURRENT	**1 - RECLOSER TIMERS**	**1 - RECL_1 GR TIME**
2 - VOLTAGE	2 - SEQNCE CNTL TIMERS	**2 - RECL_2 PH TIME**
3 - RECLOSER	3 - SEQNCE CNTL	**3 - RECL_2 GR TIME**
4 - LOGIC	4 - TRIP ENABLE	**4 - RECL_3 PH TIME**
5 - BREAKER SUPV	5 - RECLOSER ENABLE	**5 - RECL_3 GR TIME**
6 - HISTORICAL RECORD		**6 - RECL_4 PH TIME**
7 - OSCILLOGRAPHY (*)		**7 - RECL_4 GR TIME**

0 - GENERAL	0 - RECL. IN SERVICE	**0 - RATED VAC TIME**
1 - CURRENT	1 - RECLOSER TIMERS	**1 - INHIBIT TIME**
2 - VOLTAGE	**2 - SEQNCE CNTL TIMERS**	**2 - PH RESET TIME**
3 - RECLOSER	3 - SEQNCE CNTL	**3 - GR RESET TIME**
4 - LOGIC	4 - TRIP ENABLE	**4 - MNCL RESET TIME**
5 - BREAKER SUPV	5 - RECLOSER ENABLE	**5 - SEQUENCE CHK TIME**
6 - HISTORICAL RECORD		**6 - MNCL TIME DELAY**
7 - OSCILLOGRAPHY (*)		

0 - GENERAL	0 - RECL. IN SERVICE	**0 - NO OF RECLOSES**
1 - CURRENT	1 - RECLOSER TIMERS	**1 - MNCL VAC SUPV**
2 - VOLTAGE	2 - SEQNCE CNTL TIMERS	**2 - RECL VAC SUPV**
3 - RECLOSER	**3 - SEQNCE CNTL**	**3 - MNCL INHIBIT SUPV**
4 - LOGIC	4 - TRIP ENABLE	**4 - RECL INHIBIT SUPV**
5 - BREAKER SUPV	5 - RECLOSER ENABLE	**5 - RECL INHIBIT TIME**
6 - HISTORICAL RECORD		
7 - OSCILLOGRAPHY (*)		

(*) Optional.

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0 - GENERAL	0 - RECL. IN SERVICE	**0 - TRIP/RECLS RESET**
1 - CURRENT	1 - RECLOSER TIMERS	**1 - TRIP/1ST RECLOSE**
2 - VOLTAGE	2 - SEQNCE CNTL TIMERS	**2 - TRIP/2ND RECLOSE**
3 - RECLOSER	3 - SEQNCE CNTL	**3 - TRIP/3RD RECLOSE**
4 - LOGIC	**4 - TRIP ENABLE**	**4 - TRIP/4TH RECLOSE**
5 - BREAKER SUPV	5 - RECLOSER ENABLE	**5 - TRIP @ EXT MNCL**
6 - HISTORICAL RECORD		**6 - TRIP @ RECL MNCL**
7 - OSCILLOGRAPHY (*)		

0 - GENERAL	0 - RECL. IN SERVICE	
1 - CURRENT	1 - RECLOSER TIMERS	**0 - RECL INIT @ RESET**
2 - VOLTAGE	2 - SEQNCE CNTL TIMERS	**1 - RECL INIT 1ST CLS**
3 - RECLOSER	3 - SEQNCE CNTL	**2 - RECL INIT 2ND CLS**
4 - LOGIC	4 - TRIP ENABLE	**3 - RECL INIT 3RD CLS**
5 - BREAKER SUPV	**5 - RECLOSER ENABLE**	**4 - RECL INIT 4TH CLS**
6 - HISTORICAL RECORD		
7 - OSCILLOGRAPHY (*)		

(*) Optional.

Logic Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	**0 - TRIP SEAL-IN ENABLE**
1 - OPERATIONS	1 - CURRENT	**1 - OPEN FAILURE TIMER**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - CLS FAILURE TIMER**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - RECL MNCL ENABLE**
4 - INFORMATION	**4 - LOGIC**	**4 - COORDINATION TIME (**)**
	5 - BREAKER SUPV	
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

(*) Optional.
(**) 7IVD-L Model.

Breaker Supervision Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	**0 - EXCESS NO OF TRIP**
1 - OPERATIONS	1 - CURRENT	**1 - I2 I ALARM**
2 - ACTIVE GROUP	2 - VOLTAGE	**2 - I2 I CUMULATIVE**
3 - CHANGE SETTINGS	3 - RECLOSER	**3 - TRIP COIL CKT SUPV**
4 - INFORMATION	4 - LOGIC	**4 - CLS COIL CKT SUPV**
	5 - BREAKER SUPV	
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

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History Log Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	
1 - OPERATIONS	1 - CURRENT	
2 - ACTIVE GROUP	2 - VOLTAGE	**0 - CALC T INTERVAL**
3 - CHANGE SETTINGS	3 - RECLOSER	**1 - DATA RECORD INTERVAL**
4 - INFORMATION	4 - LOGIC	**2 - DAY CALENDAR MASK**
	5 - BREAKER SUPV	**3 - HOUR RANGE**
	6 - HISTORICAL RECORD	
	7 - OSCILLOGRAPHY (*)	

(*) Optional.

Oscillographic Settings: HMI Access

0 - CONFIGURATION	0 - GENERAL	
1 - OPERATIONS	1 - CURRENT	**0 - FIXED TIME**
2 - ACTIVE GROUP	2 - VOLTAGE	**1 - OVERWRITE**
3 - CHANGE SETTINGS	3 - RECLOSER	**2 - INITIATE METHOD**
4 - INFORMATION	4 - LOGIC	**3 - INITIATE ELEMENTS**
	5 - BREAKER SUPV	**4 - NO OF CHANNELS**
	6 - HISTORICAL RECORD	**5 - PRE-FAULT TIME**
	7 - OSCILLOGRAPHY (*)	**6 - RECORD LENGTH**

(*) Optional.

- ### Information Menu: HMI Access

0 - CONFIGURATION	**0 - SETTINGS**
1 - OPERATIONS	**1 - CONFIGURATION**
2 - ACTIVE GROUP	**2 - TRIPS**
3 - CHANGE SETTINGS	**3 - STATUS**
4 - INFORMATION	**4 - METERING**

Settings Information: HMI Access

0 - CONFIGURATION	**0 - SETTINGS**	**0 - GENERAL**
1 - OPERATIONS	1 - CONFIGURATION	**1 - CURRENT**
2 - ACTIVE GROUP	2 - TRIPS	**2 - VOLTAGE**
3 - CHANGE SETTINGS	3 - STATUS	**3 - RECLOSER**
4 - INFORMATION	4 - METERING	**4 - LOGIC**
		5 - BREAKER SUPV
		6 - HISTORICAL RECORD
		7 - OSCILLOGRAPHY (*)

This menu is identical to the one of Change Settings, as well as its later development, since it talks about to the information on these settings.

(*) Optional.

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Configuration Information: HMI Access

0 - CONFIGURATION	0 - SETTINGS	**0 - OPERATION ENABLE**
1 - OPERATIONS	**1 - CONFIGURATION**	**1 - COMMUNICATIONS**
2 - ACTIVE GROUP	2 - TRIPS	**2 - DATE & TIME**
3 - CHANGE SETTINGS	3 - STATUS	**3 - PHASE SEQ.**
4 - INFORMATION	4 - METERING	**4 - LANGUAGE**
		5 - NOMINAL FREQ. (*)

0 - SETTINGS	**0 - OPERATION ENABLE**	**0 - BREAKER**
1 - CONFIGURATION	1 - COMMUNICATIONS	**1 - RECLOSER**
2 - TRIPS	2 - DATE & TIME	**2 - REMOTE SETTINGS**
3 - STATUS	3 - PHASE SEQ.	**3 - BLOCK / RESET GND E. (*)**
4 - METERING	4 - LANGUAGE	
	5 - NOMINAL FREQ. (*)	

0 - SETTINGS	0 - OPERATION ENABLE	**0 - TERMINAL ADDRESS**
1 - CONFIGURATION	**1 - COMMUNICATIONS**	**1 - BAUD RATE**
2 - TRIPS	2 - DATE & TIME	**2 - STOP BITS**
3 - STATUS	3 - PHASE SEQ.	**3 - PARITY**
4 - METERING	4 - LANGUAGE	**4 - PARITY FRONTAL P.**
	5 - NOMINAL FREQ. (*)	**5 - COM TIMEOUT**

(*) 7IVD-L Model.

Trips Information: HMI Access

0 - CONFIGURATION	0 - SETTINGS	**DP:**
1 - OPERATIONS	1 - CONFIGURATION	
2 - ACTIVE GROUP	**2 - TRIPS**	**RECL. RESET**
3 - CHANGE SETTINGS	3 - STATUS	**NO RECL:**
4 - INFORMATION	4 - METERING	

Records Information: HMI Access

0 - CONFIGURATION	0 - SETTINGS	**0 - ALARMS**
1 - OPERATIONS	1 - CONFIGURATION	**1 - RECL / BREAK / GND E. (*)**
2 - ACTIVE GROUP	2 - TRIPS	**2 - MEASURING ELEMENTS**
3 - CHANGE SETTINGS	**3 - STATUS**	**3 - STATUS INPUTS**
4 - INFORMATION	4 - METERING	**4 - AUXILIARY OUTPUTS**

(*) 7IVD-L Model.

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Metering Information: HMI Access

0 - CONFIGURATION	0 - SETTINGS	**0 - CURRENTS**
1 - OPERATIONS	1 - CONFIGURATION	**1 - VOLTAGE**
2 - ACTIVE GROUP	2 - TRIPS	**2 - MAX / MIN CURRENTS**
3 - CHANGE SETTINGS	3 - STATUS	**3 - MAX VOLTAGE**
4 - INFORMATION	**4 - METERING**	**4 - POWER**
		5 - SEQUENCE CURRENTS
		6 - FREQUENCY

7IVD-L

0 - CONFIGURATION	0 - SETTINGS	**0 - CURRENTS**
1 - OPERATIONS	1 - CONFIGURATION	**1 - MAX / MIN CURRENTS**
2 - ACTIVE GROUP	2 - TRIPS	**2 - SEQUENCE CURRENTS**
3 - CHANGE SETTINGS	3 - STATUS	**3 - VOLTAGE**
4 - INFORMATION	**4 - METERING**	**4 - VOLTAGES COMPUEST.**
		5 - MAX / MIN POWER
		6 - POWER
		7 - MAX / MIN POWER
		8 - FREQUENCY
		9 - ENERGY

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8.5 Control Function Access

The screen of the Alphanumeric Display associated with the Control functions is characterized by displaying the word **[CON]** in the upper right part.

The following table describes, the structure of the screens associated with the Control functions and the method of access.

All the functions in the equipment associated with the Control module are affected by variations in the Configuration. Therefore, the menus found in the option **Change Settings** (**Generals**, **Times**, **Logic Settings** and **Analog**) will vary depending on the Configuration loaded in the equipment. The table corresponds to a specific case but is useful as an example of the Alphanumeric Display menu structure associated with the Control Subsystem.

- **Configuration Settings: HMI Access**

0 - CONFIGURATION	**0 - PASSWORDS**
1 - CHANGE SETTINGS	**1 - COMMUNICATIONS**
2 - LOAD CONFIG PROGRAM	**2 - DATE AND TIME**

0 - CONFIGURATION	**0 - PASSWORDS**	**0 - PASSWORD 1**
1 - CHANGE SETTINGS	1 - COMMUNICATIONS	**1 - PASSWORD 2**
2 - LOAD CONFIG PROGRAM	2 - DATE AND TIME	**2 - PASSWORD 3**

0 - CONFIGURATION	0 - PASSWORDS	**0 - TERMINAL ADRESS**
1 - CHANGE SETTINGS	**1 - COMMUNICATIONS**	**1 - BAUD RATE**
2 - LOAD CONFIG PROGRAM	2 - DATE AND TIME	**2 - STOP BITS**
		3 - PARITY
		4 - FRONTAL PARITY (*)
		5 - FREQUENCY (*)

0 - CONFIGURATION	0 - PASSWORDS
1 - CHANGE SETTINGS	1 - COMMUNICATIONS
2 - LOAD CONFIG PROGRAM	**2 - DATE AND TIME**

(*) 7IVD-L Model.

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- **Change Settings: HMI Access**

0 - CONFIGURATION	**0 - GENERAL**
1 - CHANGE SETTINGS	**1 - TIMER**
2 - LOAD CONFIG PROGRAM	**2 - LOGICS**
	3 - ANALOGICS

0 - CONFIGURATION	**0 - GENERAL**	**0 - IT RATIO**
1 - CHANGE SETTINGS	1 - TIMER	**1 - TRANSDUCER 1**
2 - LOAD CONFIG PROGRAM	2 - LOGICS	**2 - TRANSDUCER 2**
	3 - ANALOGICS	**3 - TRANSDUCER 3**
		4 - TRANSDUCER 4

0 - CONFIGURATION	0 - GENERAL	**0 - TIMER 1**
1 - CHANGE SETTINGS	**1 - TIMER**	**1 - TIMER 2**
2 - LOAD CONFIG PROGRAM	2 - LOGICS	
	3 - ANALOGICS	

0 - CONFIGURATION	0 - GENERAL
1 - CHANGE SETTINGS	1 - TIMER
2 - LOAD CONFIG PROGRAM	**2 - LOGICS**
	3 - ANALOGICS

0 - CONFIGURATION	0 - GENERALES
1 - CHANGE SETTINGS	1 - TIMER
2 - LOAD CONFIG PROGRAM	2 - LOGICS
	3 - ANALOGICS

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9. Local Interface: Graphic Display

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9.1 General

This chapter will only analyze part of the graphic display and its function keys (figure 9.1). Note that the graphic display described in this chapter is associated with the control subsystem. The signals and symbols depend not only on the model but also on the configuration. The examples aim to illustrate how the display works, not to faithfully indicate each screen of each specific IED.

The liquid crystal graphic display is 114 x 64 mm (240 x 128 pixels). It is self-illuminated and has the following five function keys:

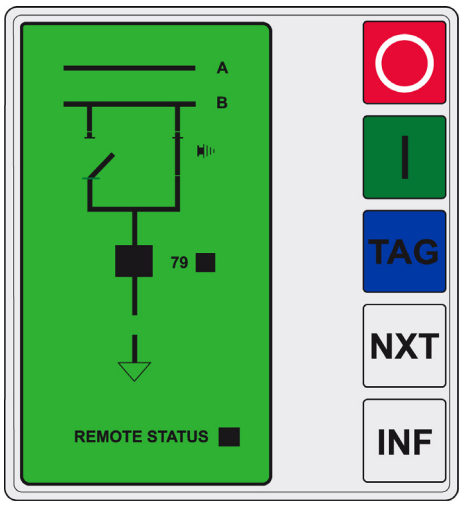

Figure 9.1: Local Control Graphic Display.

Functions	Serigraphy	Color
Open / Out of service / Manual / Local	O	Red
Close / In service / Automatic / Remote / Unblock	I	Green
Tagged	TAG	Blue
Selection	NXT	Grey
Information	INF	Grey

In model **7IVD-L**, the **O** and **I** keys also *lockout* and *unlock* the ground measuring elements respectively. You can use the **I** key to *locally* activate a protection settings group from control.

The graphic display is only operational when the alphanumeric display is on the default screen in control mode (**[CON]** in the upper right part of the display). If it is in protection mode, the position must be switched to control mode with the **F3** key. The graphic display initially presents the symbol of the monitored bay. From this situation, there are two options: access the information screens (with the **INF**) function key or access the various elements of the single-line diagram to operate on them (through the **NXT** function key). The information screens and the elements of the single-line diagram are accessed correlatively. From any information screen, if the **INF** key is not pressed again in 60 s, it returns to the default screen. Likewise, if more than 10 s elapse without pressing the **NXT** key, the display reverts to the no element selected state. If you press **NXT** before time-out, each single-line diagram element is selected one by one until the no element selected situation is reached again. The icon of the element selected blinks and graphically represents the state that it is in (see figure 9.2.)

In the default state, the graphic display shows the single-line diagram of the bay, indicating the state of the various elements. The elements represented depend on the specific model, and the information associated with each single-line diagram element depends on the configuration of each specific IED.

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9.2 Symbols Used in the Graphic Display

The default *screen* shows a single-line diagram of the monitored bay. Therefore, this screen depends on the specific model. The symbols used to represent the elements are the following:

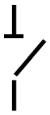
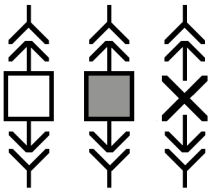
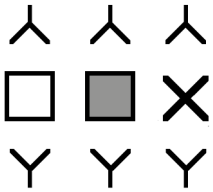
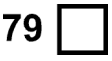
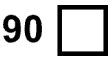
Element	State 1	State 2
Breaker	Open	Closed
Breaker	Unknown (0-0) (dual signal input)	Unknown (0-0) (dual signal input)
Switch	 Open	Closed
Position of the breaker mechanism	 Plugged	 Unplugged
Position of the breaker mechanism	Pulled out / Closed	Pulled out / Open
Recloser	In service	 Out of service
Automatic load transfer	Automatic	Manual
Voltage regulator	Automatic	 Manual

Figure 9.2: Symbols that Represent the Devices.

In model **7IVD-L**, other elements such as state of ground measuring elements and group 1, 2 or 3 can be defined, each with its own symbol.

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Each device's representation will depend on the state of one or more digital input signals. The following types of representation can exist:

- Two-position devices associated with a single signal
- Two-position devices associated with two signals
- Devices that depend on multiple signals

- **Two-position devices (open/closed) associated with a single signal**

The representation of this type of element depends on the active / inactive status of a single digital input. Usually "closed" matches the "active" status of the corresponding digital input in the control subsystem. Examples of this type of devices are programmable control functions, lockouts or some kind of disconnecting switch.

For the **7IVD-L** model, this device could be applied to the **lockout** / **unlock** state of the ground measuring elements.

- **Two-position devices (open/closed) associated with two signals**

The most common examples of this type of device are power switches and disconnecting switches. Their representation depends on the active / inactive status of two switched digital inputs that are activated alternatively for each position of the main element. The following states can be represented:

Contact “a”	Contact “b”	Status
0	0	Unknown
0	1	Open
1	0	Closed
1	1	Unknown

The unknown state will be detected after a time delay to allow proper change of status to occur. The delay will vary between 1 and 30 seconds, depending on the type of device.

- **Devices that depend on multiple signals**

Examples of this type of device are switchgear breakers and three-position circuit breakers. The representation of switchgear breakers will depend on the following states:

- **Open** breaker position (contact type "b")
- **Closed** breaker position (contact type "a")
- **Unplugged** breaker mechanism position
- **Pulled out** breaker mechanism position

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Devices of this type are represented as follows:

- When the **pulled out** signal is active, the corresponding symbol in figure 9.2 will appear without displaying the breaker's status and independently of its status.

- When the **unplugged** signal is active (1) without being **pulled out**, the breaker will be represented according to the "a" and "b" contacts states. As indicated in figure 9.2, the continuity section from the breaker to the plug-in terminals that go to the bus and line will not be displayed.

- When the **unplugged** signal is not active (0), the breaker will be represented according to the "a" and "b" contact states. As indicated in figure 9.2 (plugged), the continuity section from the breaker to the plug-in terminals that go to the bus and line is displayed.

For double configuration buses using switchgear, the IED is designed so it can separately perform commands (independent digital inputs and outputs) on each connected position (buses A and B) independently of whether the position is equipped with two mounted breakers (the case of transformer taps and partition of busbars) or with a single mounted breaker (the case of line positions and capacitor bank).

In the case of the three-position circuit breakers, the representation will depend on the states of three digital inputs corresponding to the breaker's three possible states: **connected to bus**, **open** and **grounded**.

When, after time delay, two or more signals are simultaneously detected or no signals are detected, the unknown status will be generated. This device is treated as two superimposed circuit breakers. You can select both by means of the graphic *display's* keypad: **line circuit breaker** and **ground circuit breaker**.

Similarly, control operations are performed separately, as if they were two (2) independent devices upon which open and close commands can be executed independently. These commands can be:

- **Line circuit breaker** “OPEN command”
- **Line circuit breaker** “CLOSE command”
- **Ground circuit breaker** “OPEN command”
- **Ground circuit breaker** “CLOSE command”

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9.3 Accessing the Information

As pointed out in paragraph 9.1, the graphic display is only operational when the alphanumeric display is in the default situation in control mode (**[CON]** in the upper right part of the display). Starting with this situation, pressing the **INF** key brings up the various accessible information screens in the graphic display correlatively. Note that, while viewing any of the information displays, unless **INF** is pressed again in less than 60 seconds, it will return to the default display. Figure 9.3 is the block diagram of the configuration of the information displays.

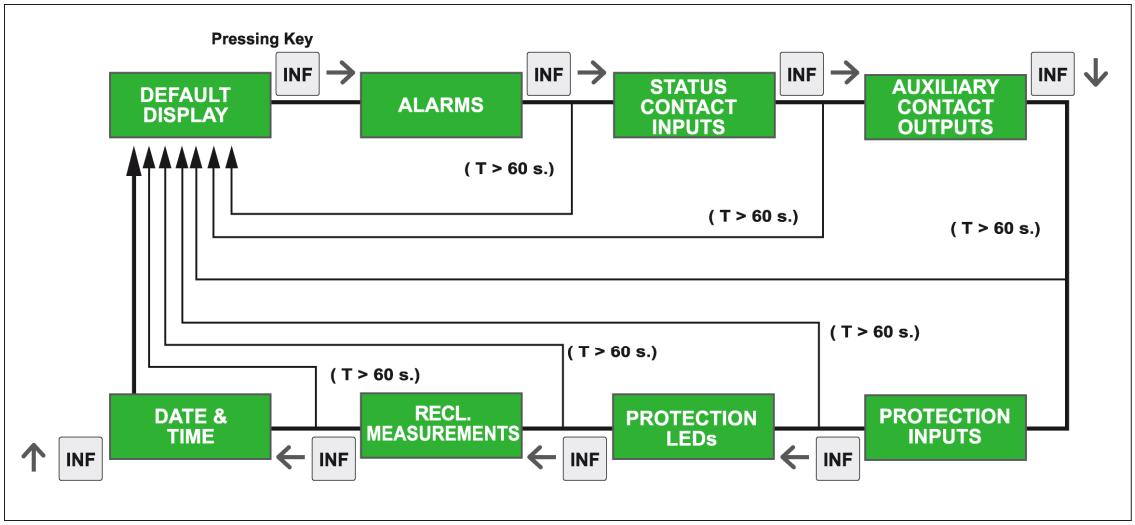

Figure 9.3: Information Menu.

Pressing the information key, **INF**, from the default screen brings up the following screens in this order:

- Alarms screen
- Control subsystem digital inputs screen (DI)
- Control subsystem digital outputs screen (DO)
- Protection inputs screen (PI)
- Protection LEDs screen (PL)
- Metering screen (there can be several)
- Date & time screen

The signals that appear on each of these screens depends on the configuration loaded into the specific model. In some configurations, one or more of the information screens may not be used. If there is a measuring board, there will be two **metering screens** instead of one

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9.3.1 Alarms Information

The **alarm system** screen appears as shown in figure 9.4. Each alarm point is associated with a 3-line annunciator window. The number of alarm points represented depends on the model. If more than eight alarm points need to be viewed, they will be presented on successive screens (up to 3 screens, 24 alarm points) with the same layout as the one shown here (the specific configuration is determined ex factory).

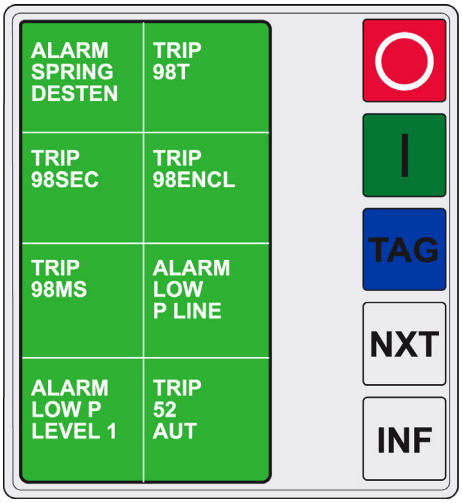

Figure 9.4: Alarms Information Screen.

The signals used to define the alarm points are part of the control subsystem element called **alarm system**. The configuration specifies which physical input, input from protection or logic output signal is associated with each of the alarm points and the message to appear in the graphic display.

The configuration that determines the input signals to the **alarm system** (logic outputs, physical inputs or protection inputs) and the logic established for processing them varies for each specific mode.

- **Alarm system without acknowledgement**

If the alarms are not managed at the **UCP** level (alarm panel configuration **without acknowledgement**), windows not in alarm status will have a continuous display. The messages will blink with a cadence of 0.5 s when the signals are active. When the alarm point signal returns to normal, the window stops blinking.

- **Alarm system with acknowledgement**

If the alarms are managed at the UCP level (**alarm panel configuration with acknowledgement**), only those windows with an active alarm point will display an alarm message. Points not in alarm status will have a blank display.

Points in alarm that have not been acknowledged will blink with a cadence of 0.5 s. When acknowledged, it disappears from the screen if the signal that activates it has been annulled, and persists without blinking otherwise. Section 9.4.5 of this same chapter provides a more detailed analysis of the alarm management procedure. Alarms are acknowledged with the function key associated with the alphanumeric display, **F1**. Pressing this key acknowledges all the alarms.

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9.3.2 Digital Input / Output Indication Information

The screens associated with the digital inputs, digital outputs, protection inputs and protection LEDs are also model-specific.

Up to 30 signals can be displayed on a single screen and the layout is as in figure 9.5. If more than 30 signals are used, additional screens will be provided. If less than 30 signals are used, only those that have been predetermined for the specific case will be displayed.

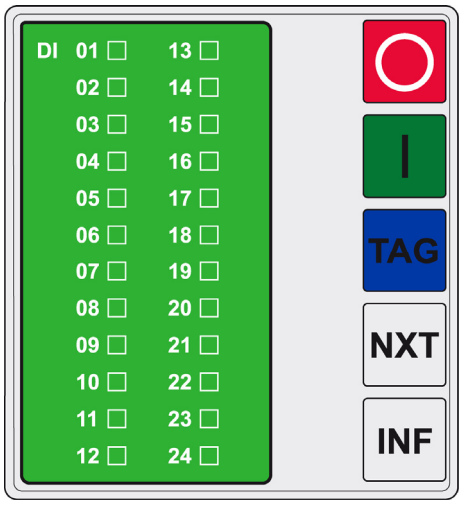

Figure 9.5: Display of Active Inputs/Outputs.

Active signals are represented by a full rectangle (simulating a LED). The rectangle is empty if the signal is not active. The association of the information to be represented and each of the rectangles depend on the configuration loaded in the IED.

Digital outputs, protection inputs and protection LEDs are displayed on similar screens. **DI**XX is replaced with **DO**XX, **PI**XX or **PL**XX respectively, where XX represents the signal number. **PI**XX input signals to the control subsystem originate in the protection subsystem. They also vary for each specific model.

9.3.3 Measurement Information

The measurement information displayed also depends on the IED configuration. Figure 9.6 is an example. The # symbol represents a number.

The first frame always includes the value of the current measurement and the rated voltage values (depending on the configuration, there can be one, two, three or four rated voltage values). The second frame displays values derived from input transducers (which can be values of active, reactive or calculated power using inputs from instrument transformers). The third frame displays counter register information.

The last rectangle displays automatic reclose attempts: the first is the number of "first reclose" attempts; the second value is the number of other attempts.

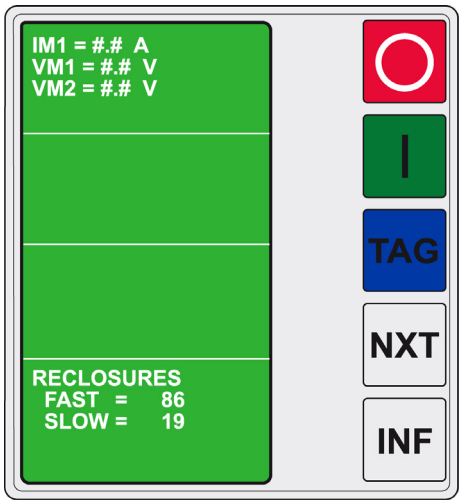

Figure 9.6: Measures Information Screen.

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The screen in figure 9.7 generally corresponds to the measurement circuit board. Frame 1 presents all the configured current values. The second frame displays the voltages and the third frame gives the values of the powers, frequency and energies.

IEDs that do not have a measurement circuit board have a similar screen that captures currents and voltages in protection and uses them to calculate the powers, PF, frequency and energies to pass them on to control (the frames disappear).

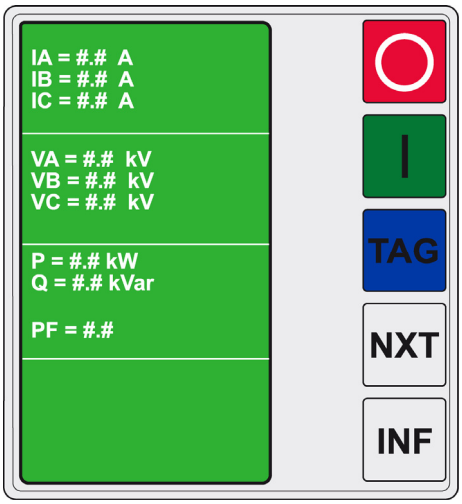

Figure 9.7: Second Measures Information Screen.

If the IED configuration does not include information that would appear in one or more of these frames, that frame will be empty.

9.3.4 Date and Time Information

The last screen before returning to the default display presents the date and time in the center of the screen as shown in figure 9.8.

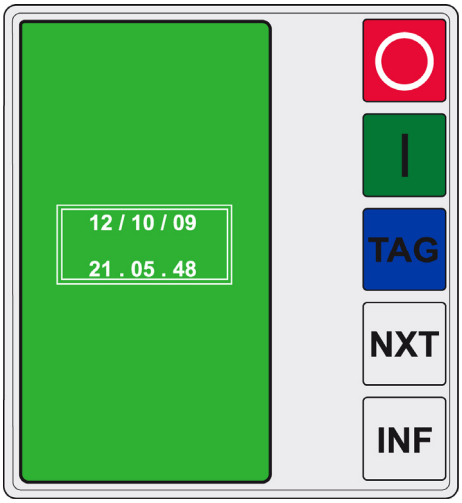

Figure 9.8: Date & Time Screen.

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9.4 How the Control Functions Work

The control functions are performed chiefly through the graphic display with the help of the 5 control keys described above. The indication **[CON]** must be visible in the upper right corner of the alphanumeric display for the control keys to be operational.

As indicated in Chapter 7, Description of the Operation of the Control Subsystem, the logic analyses and determines which actions on the elements of the bay are feasible or not depending on the configuration. The control functions are designed to adapt to the various possible bay configurations.

9.4.1 General Procedure for Executing Maneuvers

The execution of a command always follows the same steps independently of the type of device that it acts upon. This coherence aims to facilitate operation for the personnel responsible for the IED.

Pressing the selection key, **NXT**, cyclically highlights each of the bay devices upon which a command can be executed. This highlighting consists in the corresponding image blinking with a 1-second cadence. If no command is received during the ten seconds following the selection of the element, the module automatically aborts the selection and returns to the default state, which is no element selected. The part of the image that blinks during the selection is the whole icon minus the associated texts.

The predetermined order of selection is always the same, but varies according to the configuration of the specific IED. An example for a specific bay could be the following succession:

- LOCAL/REMOTE status
- Panel CONNECTED/DISCONNECTED state
- Bus selector disconnectors
- Breaker
- Associated devices (recloser, programmable control function, etc...)
- Lockout of the ground measurement elements (7IVD-L)
- Change of active protection group (7IVD-L)
- Disconnectors of grounding on the bus side
- Disconnectors of grounding on the line side
- By-pass disconnectors and, ultimately, nothing

After selecting the element to be monitored, press the key corresponding to the **command** (to **close** or to open). Should the command not be executable for any cause, the display will present two lines of text indicating that execution is impossible and the reasons why:

LINE 1: **COMMAND NOT EXECUTABLE**
LINE 2: **TAGGED**
INTERLOCKING
REMOTE STATUS

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This message will disappear after five (5) seconds. During that period, no operations can be executed. When it is impossible to classify the reason why a command can not be executed under either of the two texts above, the second line of text is not displayed and only the **ORDER NOT EXECUTABLE** message appears. The possible causes for a non-executable local command are the following:

- The attempted command tries to change the selected device status to its existing status (for example, a command to close a breaker that is already closed). In this case, nothing will be indicated in the second line.
- The bay is in **Remote Status**.
- A **Close** command is sent to a breaker that is **Tagged**.
- The IED's internal logic process detects the activation of an interlocking that prevents the execution of the command. These interlockings correspond to the generation of internal logic signals of independent **Open** or **Close** permissions for each device. The generation of the close or open permissions uses combinations of the IED's digital inputs in conjunction with internal logic signals generated from field digital inputs, internal states of the IEDs, internal signals from protection and the metering module, as well as internal signals from the central unit through the communications protocol.

Verification that the command is executable activates the command's auxiliary output contacts. After the order has been executed, the IED checks the proper execution of the command by monitoring the digital inputs or internal logic signals. If, after a given interval of time (selectable for each device), it is detected that the command has failed, the display shows a **COMMAND FAILURE** message like the one already described. If the command has been executed properly, the IED sends no indication to the exterior

9.4.2 Procedure for opening / closing breakers and disconnecting switches

The procedure for opening or closing breakers or disconnecting switches is the same for both, and follows the general procedure described above. As a consequence of the operations, an output signal is activated and presented on the digital outputs screen (depending on the model).

The last action after the execution of a command, and depending on the outcome produced, a message is sent to the central unit following the communications protocol implemented: **PROCOME, DNP3...** (as indicated in Chapter 7). The messages sent are the following:

- Change of state of the device upon which the command is executed.
- **Command failure** signal if such is the outcome.
- **Command executed** signal.

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- **Opening or closing three-position disconnectors**

Three-position disconnectors are analyzed as if they were two 2-position disconnecting switches, one on ground and another on buses, represented by two superimposed, selectable symbols like any other device. Therefore, follow this procedure to maneuver on a three-position disconnector:

Use the **NXT** key to select the relevant disconnecting switch: **busbar disconnector** or **ground circuit breaker**. The opening and closing maneuvers are performed according to the general procedure described above.

The procedure is identical to that followed by a two-position disconnecting switch. The only difference is that the three-position disconnector is achieved by associating different, selectable two-position disconnecting switches.

9.4.3 Breaker Tagging Procedure

Follow these steps to enable or disable the **tagging status** of a breaker: from the default screen, select the breaker to be tagged with the **NXT** function key. Before 30 s transpire, press the **TAG** key. If the breaker was **in service** (not tagged out), the logic checks whether the breaker is open or not. If it is open, the **tagging operation** is allowed. Should the breaker be in a state other than **open**, the tagging command will not be executed and the **COMMAND NOT EXECUTABLE** message will appear.

Once the breaker is changed to **tagged** status, a **T** appears beside the breaker on the screen. The corresponding signal is generated and sent to the central unit through the protocol implemented: **PROCOME, DNP3...**

If the **tagging** function is removed, the **T** indication disappears from the screen and the change-of-state signal is generated and sent to the central unit through the protocol.

The **tagging** status will only affect the breakers as defined in the configuration, which is generally as follows:

- **Tagged status**: the breaker can not receive local or remote closing commands.
- **Not tagged status**: any kind of command may be given depending on the state of the breaker.

The **tagged** status can only by implemented when the breaker is already open. This status can be performed locally by the position. The **disabled bay** status can be exited no matter what position the breaker is in: **open**, **closed** or **unknown**.

In some configurations, **disabled bay** status activation triggers an interlocking, which provokes the continuous opening and closing of a digital output (for example, obstruction to operating on disconnecting switches, etc.).

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9.4.4 Control Procedure for other Logical Devices

This procedure is identical to the procedures explained in the preceding sections. The following devices fall into this group:

- State of the IED'S **programmable control functions.**
- Lockouts.
- **Local / remote control** state of the bay**.**
- Panel **connected / disconnected** state.

As a consequence of the execution of this type of commands, the unit modifies the internal state of the logic signals and generates the incidences of transmission of changes of state through the protocol implemented: **PROCOME, DNP3...** In this type of commands, what is established for **COMMAND FAILURE** will not apply since no applicable return signal exists.

9.4.5 Procedure for Managing Alarms

This procedure is only applicable when the alarms are managed at the UCP level, that is, when the alarm system is configured **with user acknowledgement**. Each input to the alarm system screen can appear as an empty window, or blinking or fixed message depending on the alarm signal's status.

To acknowledge an alarm, use the **F1** function key of the alphanumeric display. Each time this key is pressed, all the alarms are acknowledged. Alarm states and resent functions are shown graphically in the flow chart of figure 9.9.

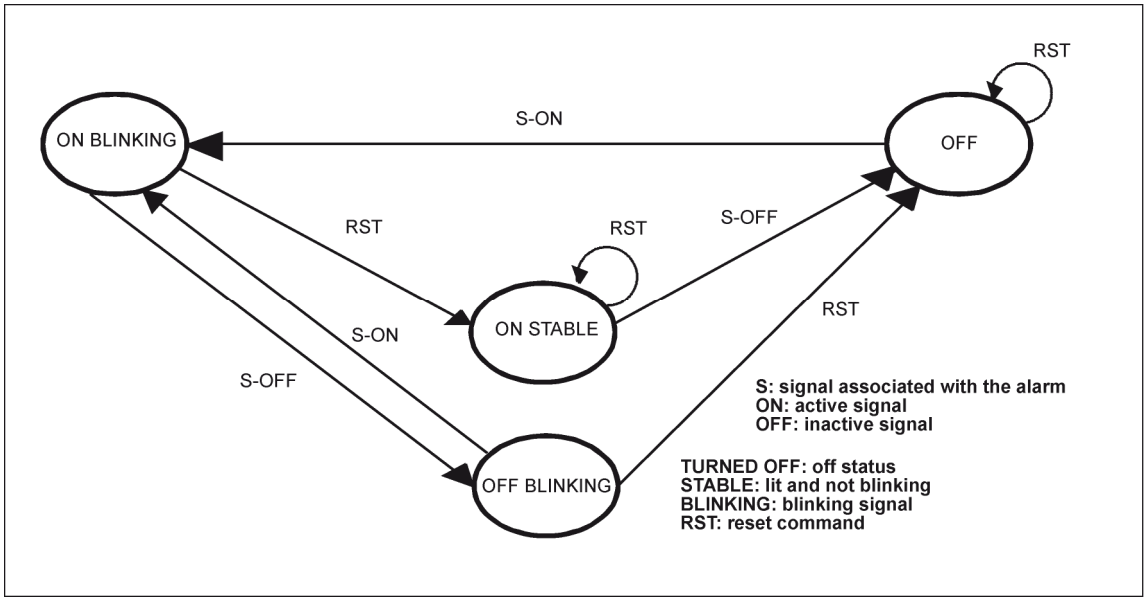

Figure 9.9: Alarm Management Sequence.

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When the indication of an active signal appears, the message associated with the alarm blinks. If you press **F1**, the alarm is acknowledged. If the signal remains active, the text is fixed and it turns off as soon as the signal disappears. If the signal is deactivated before it is acknowledged, the message goes on blinking until it is acknowledged by pressing **F1**, and then it turns off.

The various possible states of the alarms depending on the message that appears in the alarm system are the following:

- **Fixed message**: alarm signal is active and the alarm has been acknowledged.
- **Blinking message**: alarm signal is active or inactive and alarm is unacknowledged.
- **No message**: alarm signal is inactive alarm and the alarm has been acknowledged.

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10. Receiving Test

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10.1 General

Improper handling of electrical equipment is extremely dangerous. When not done properly, there is a risk of serious personal injury or harm to the materials. Therefore, only skilled and qualified personnel familiar with appropriate safety procedures and precautions should work with this equipment.

The following general safety precautions are provided as a reminder:

- High magnitude voltages are present in auxiliary power supply and metering circuits **even after you have disconnected after the equipment**.
- **Solidly ground** equipment before handling or operating.
- Under no circumstances should the operating limits of the equipment be exceeded (voltage, current, etc.).
- **Disconnect** the auxiliary power supply voltage (AC or DC) **from the IED** before extracting or inserting any module; otherwise damage may result.

The number, the type and the specific characteristics of the acceptance tests for the various models are listed in the following table.

7IVD-J **7IVD-K** **7IVD-L**	**Protection and Control**	Preliminary inspection
		Insulation test
		Verification of power supply sources
	Protection	Metering test
		Current elements test
		Directional element test (**model 7IVD-L**)
		Voltage elements test
		Frequency elements test
		Open phase element test
		Residual current unit test
		Breaker failure detection test
		Recloser test
		Trip / close coil circuit supervision input test
	Control	Control subsystem test configuration
		Status contact inputs and LEDs test
		Auxiliary contact outputs test
		Metering test
	Communications	Communications Test

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10.1.1 Accuracy

The accuracy of the measuring instruments and test source signals (auxiliary power supply voltage, AC currents and AC voltages) is key in electrical testing. Therefore, you can only reasonably verify the information specified in the Technical Data section of this manual with test equipment under normal reference conditions and with the tolerances indicated in the **UNE 21-136** and **IEC 255** standards in addition to using precision instruments.

It is extremely important that there be little or no distortion (<2%) in the test source signals as harmonics can affect internal measuring of the equipment. For example, distortions will affect this IED, made up of non-linear elements, differently from an AC ammeter, because the measurement is made differently in both cases.

It must be emphasized that the accuracy of the test will depend on the instruments used for measuring as well as the source signals used. Therefore, tests performed with secondary equipment should focus on operation verification and not on measuring accuracy.

10.2 Preliminary inspection

The following equipment aspects should be examined:

- The relay is in good mechanical condition, all parts are securely attached and no assembly screws are missing.
- The model numbers coincide with those specified in the IED order.

10.3 Insulation test

While testing for insulation of switchgear and external wiring, disconnect the IED to avoid damage in case the test is not performed properly or if there are shorts in the harness, since insulation testing has been performed on 100 % of the units by the manufacturer.

- **Common mode**

Short-circuit all the terminals of the IED except those of the power supply to the protection and control subsystems and measurement circuit board (if there is one), for example: (C1, C2, C3); (K1, K2, K3) and (Z1, Z2, Z3). Also disconnect the enclosure ground terminal. Then apply 2000 Vac between the interconnected terminals and the metal case for 1 min.

There are internal capacitors that can generate high voltage if you remove the test points for the insulation test without reducing the test voltage.

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10.4 Verification of the Power Supply

Connect the power supply to the protection and control subsystems and measurement circuit board (if there is one) as indicated in this table. The terminals indicated are for an IED comprised of a protection board, a control board with or without an expansion card and a measurement circuit board. For another type of device, check its external connections diagram for the terminals to use.

Table 10-1: Verification of the Power Supply

Model	Vdc Prot.	Vdc Ctrl.	Vdc Met.	WITH 1P	WITH 2P	WITH 1C	WITH 2C1.C
7IVD-J/K/L	C3(+) C2(-)	K3(+) K2(-) F3(+) F2(-)	Z3(+) Z2(-)	C6 - C4	C6 - C5	K6 - K4 F6 - F4	K6 - K5 F6 - F5

Check that when the IED is disconnected from the power supply, the contacts designated by CON 2P and CON 2C in the above table are closed, and those designated by CON 1P and CON 1C are open. Then power up the protection subsystem at its rated voltage and check that the CON 1P and CON 2P contacts change state and that the **available** LED lights up. Then power up the control subsystem and check that the CON 1C and CON 2C contacts change state and that the **available** LED lights up

10.5 Protection Subsystem Receiving Tests

10.5.1 Measurement Tests

To avoid trips during this test, disable the elements and do not allow the breaker to cut the injection of current and/or voltage. Then apply the currents indicated by way of example in table 10-1 to each of the phases and ground and check the following measurements:

Table 10-2:Measurement Tests

I or V Applied	I or V Measured	Freq. Applied. (V>20Vac)	Freq. Measured (V > 20 Vac)
X	X ± 5%	Y	Y ± 0.01 Hz

Note: To check high current values, apply them during the shortest possible time; for example, for 20 A, less than 8 seconds.

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10.5.2 Test of the Phase and Ground Current Elements

You should test the overvoltage/undervoltage elements one by one, disabling those that are not being tested at any given time. For this test, you should annul the directionality of the IED to not depend on the voltages (set **Enable pickup blocking** or **Torque control** to **NO**). Otherwise they must be injected so that the elements will be in the enable-trip zone, as indicated in the directionality tests.

- **Pickup and reset**

Set the desired pickup values for the relevant element and check its activation by operating any output configured for this purpose. You can also verify this by checking the pickup flags of the menu, **Information** - **Status** - **Elements**. You can also check that the trip flag of this menu is activated if the element trips.

Table 10-3: Test of the Phase and Ground Current Elements				
Setting of the element	**Pickup**		**Reset**	
	maximum	minimum	maximum	minimum
X	1,10 **x** X	1 **x** X	1,05 **x** X	0,95 **x** X

n the low ranges, you can extend the pickup and reset interval up to X 20 mA.

- **Operating times**

To verify the operating times, use trip outputs C7-C8 and C9-C10 or the appropriate ones for your IED (see the external connections diagram).

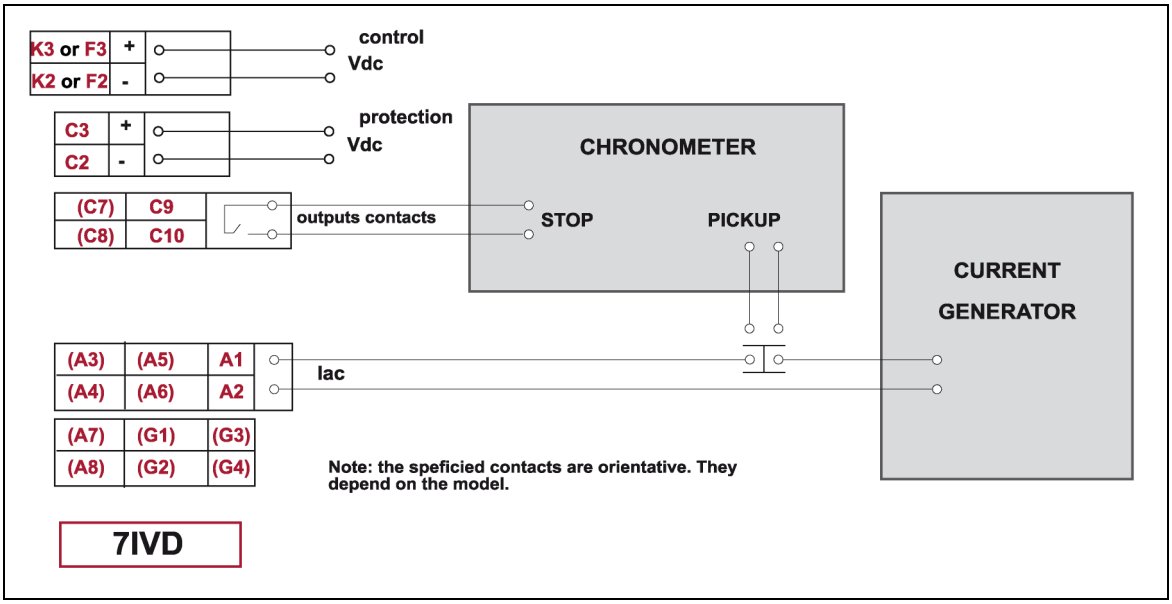

Figure 10.1: Operating Time Test Setup.

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Fixed time or instantaneous

Increase the pickup setting 20%. Operating time should be the selected time setting ±5% or 25 ms (whichever is greater). Note that a setting of 0 ms will have an operating time between 25 and 30 ms.

Inverse Time

The operating time of a given curve is determined by the time dial setting and the current applied (number of times the set pickup value; see time curve figures 6.1; 6.2 and 6.3). The tolerance is determined by applying a margin of error of 5% in the current measurement.

For model **7IVD-L**, also check the operating times for the long time-inverse and short time-inverse curves of figures 6.4 and 6.5.

10.5.3 Directional Element Test (Model 7IVD-L)

Make sure that the **enable pickup blocking** or the **torque control** is set to **YES** and that the inversion of directionality input is not operational before running the test.

You can perform the test phase by phase: Ia with Vb, Ib with Vc, Ic with Va and In with Va. Tables 10-3, 10-4 and 10-5 present the angles between which the IED must enable direction. To check whether or not the IED is seeing direction, go to the menu, **Information** - **Status** - **Metering units** - **Directional**, and verify the states of the flags of the phase being tested.

Table 10-4: Phase Directional Element Test	
V Applied	**I Applied**
Vb=64 V ∟0º	Ia=1A ∟ (360º -α char. to 180º -α char.) ±5º
Vc=64 V ∟0º	Ib=1A ∟ (360º -α char. to 180º -α char.) ±5º
Va=64 V ∟0º	Ic=1A ∟ (360º -α char. to 180º -α char.) ±5º

Table 10-5: Ground Directional (by Vpol) Element Test	
V Applied	**I Applied**
Va=64 V ∟180º	In=1A ∟ (180º +α char. to 0º +α char.) ±5º

Table 10-6:Phase Directional (by Ipol) Element Test	
V Applied	**I Applied**
Ip=1A ∟180º	In=1A ∟0º

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10.5.4 Voltage Element Test

10.5.4.a Overvoltage Element Test

Before testing the overvoltage element, disable all the voltage elements that are not being tested.

- **Pickup and reset**

Set the desired pickup values for the relevant element and check its activation by operating any output configured for this purpose. You can also verify this by checking the pickup flags of the menu, **Information** - **Status** - **Elements**. You can also check that the trip flag of this menu is activated if the element trips.

Table 10-7: Overvoltage Element Test				
Setting of the element	**Pickup**		**Reset**	
X	maximum	minimum	maximum	minimum
	1.05 x X	0.95 x X	1,00 x X	0.90 x X

- **Operating times**

To verify them, use trip outputs C7-C8 and C9-C10. [See figure 10.1]

Fixed time or instantaneous

Increase the pickup setting 20%. Operating time should be the selected time setting ±5% or 25 ms (whichever is greater). Note that a setting of 0 ms will have an operating time between 30 and 55 ms.

10.5.4.b Undervoltage Unit Test

Before testing the undervoltage element, disable all the voltage elements that are not being tested.

- **Pickup and reset**

Set the desired pickup values for the relevant element and check its activation by operating any output configured for this purpose. You can also verify this by checking the pickup flags of the menu, **Information** - **Status** - **Elements**. You can also check that the trip flag of this menu is activated if the element trips.

Table 10-8: Undervoltage Element Test				
Setting of the element	**Pickup**		**Reset**	
X	maximum	minimum	maximum	minimum
	1.05 x X	0.95 x X	1,00 x X	1.10 x X

- **Operating times**

To verify them, use trip outputs C7-C8 and C9-C10. [See figure 10.1]

Fixed time or instantaneous

Decrease the pickup setting 20%. Operating time should be the selected time setting ±5% or 25 ms (whichever is greater). Note that a setting of 0 ms will have an operating time between 30 and 55 ms.

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7IVD: Distribution Protection and Control
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10.5.5 Frequency Elements Test

Before testing these elements, disable the voltage elements that are not being tested.

- **Frequency pickup and reset**

Depending on the settings of the frequency elements (maximum or minimum), check that the pickups and resettings are within the margins indicated in table 10-8 for their rated voltage.

Table 10-9: Frequency Element Test				
Setting of the element	**Pickup**		**Reset**	
XHz	ΦA_MIN	ΦA_MAX	ΦR_MIN	ΦR_MAX
	X ±0.005 Hz	(X 0.999) ±0.005 Hz	X ±0.005 Hz	(X 1.001) ±0.005 Hz

- **Resetting the voltage**

Check that the voltage values are reset within the margin indicated in table 10-9 (where **Un** is the rated voltage.

Table 10-10: Reset Voltage		
Setting	**Reset**	
MIN. VOLTAGE	VR_MIN	VR_MAX
Un	0.95 · **Un**	1.05 · **Un**

- **Operating times**

To verify them, use trip outputs C7-C8 and C9-C10. [See figure 10.2]

To measure times, note that the voltage generator must be able to generate an up or down frequency ramp depending on the element to be tested as well as to provide an output to initiate a chronometer when it gets to the pickup frequency.

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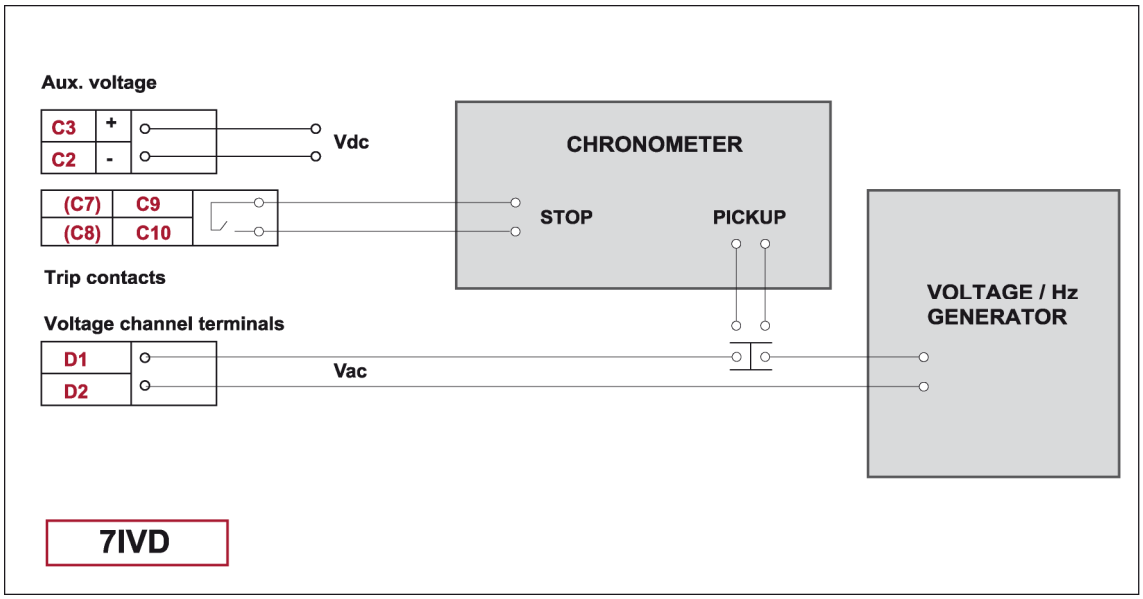

Figure 10.2: Operating Time Test Setup.

The operating times for a setting of Xs must be between (1.05 X - 0.95 X) or between (X+25 ms - X-25 ms). If the setting is 0, the operating time will be close to 60 ms.

In operating times, it is important how the frequency ramp is generated and when the chronometer starts. Set the frequency value of the signal generated very close to the threshold if you want to test and generate the broadest step possible.

If you do not have a frequency ramp generator, you can only test the maximum frequency element. Going from no voltage applied to applying voltage above the disable and the maximum frequency settings will give you a time value somewhat greater than with a frequency ramp.

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10.5.6 Open Phase Element Test

Put all the phase and ground elements out of service and apply this two-current system:

Ia = 1/0º and Ib = 1/60º (it is understood that these angles are inductive).

Set the element to 0.2 I2/I1 and check that it is not picked up. Increase the Phase B current and check that the element picks up (the pickup flag at "1") with a current value in Phase B between 1.35 Aac and 1.49 Aac. In phase B, apply a current of 2a / 60º and check that a trip is initiated in a period of time between 10.5 s and 9.5 s. Also check that the trip contacts close.

In model **7IVD-L**, set the element to 0.2 I2/I1 and the “minimum load in the line” to 1.2 A. If you apply Ia = 1/0º and Ib = 2/60º, the element should not operate. If, under the same conditions, you set the “minimum load in the line” to 0.8 A, the element should pick up.

10.5.7 Residual Current Unit Test

Check that the element picks up (the pickup flag at "1") for a setting (X) determined when it is applied by the ground input between (X × 1). For low ranges, the pickup interval can be extended to ± 20 mA. Apply a current of 2 X and check that a trip is initiated in a period of time between (Y × 1.05 - Y × 0.95.) and Y ± 25 ms, where Y is the time setting of the element.

10.5.8 Breaker Failure Detection Test

To test this element, configure one of the auxiliary contact outputs for the breaker failure function. Disable all the elements except for phase and ground instantaneous overcurrent and breaker failure.

Set the phase and ground instantaneous overcurrent pickups to 0.5 A and their time delay to zero. Set the reset levels of the breaker failure elements to the desired current reset and operating time values. Provoke a trip by applying a 1 A current phase to ground and maintain the current after the phase and ground elements trip. The breaker failure element will operate in ± 0.025 s or 5% of the set value. To verify the operation of this element, configure an auxiliary output as breaker failure.

Gradually reduce the current until the breaker failure element reaches a stable reset. Verify that this occurs for a value between ± 5% of the set value.

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10.5.9 Recloser Test

For testing the recloser function, note the following:

- The reset time after a manual close must be observed. If the trip is generated sooner, the recloser function will go to lockout.
- To initiate the reclose sequence, protection must detect that the breaker is open and that there is no current in the phases before the sequence check time (located in the group **Recloser** - **Timing Cycle control**) times out.
- If the IED is detecting failure in the open circuit supervision, it will not execute the reclosure and, therefore, it will go to lockout.
- For the recloser to complete the sequence to its definitive trip, the trips must be generated.
- Also note whether or not the rated voltage and inhibition input options are being used, as well as the inhibitors of the elements, trip masks and reclosure function.

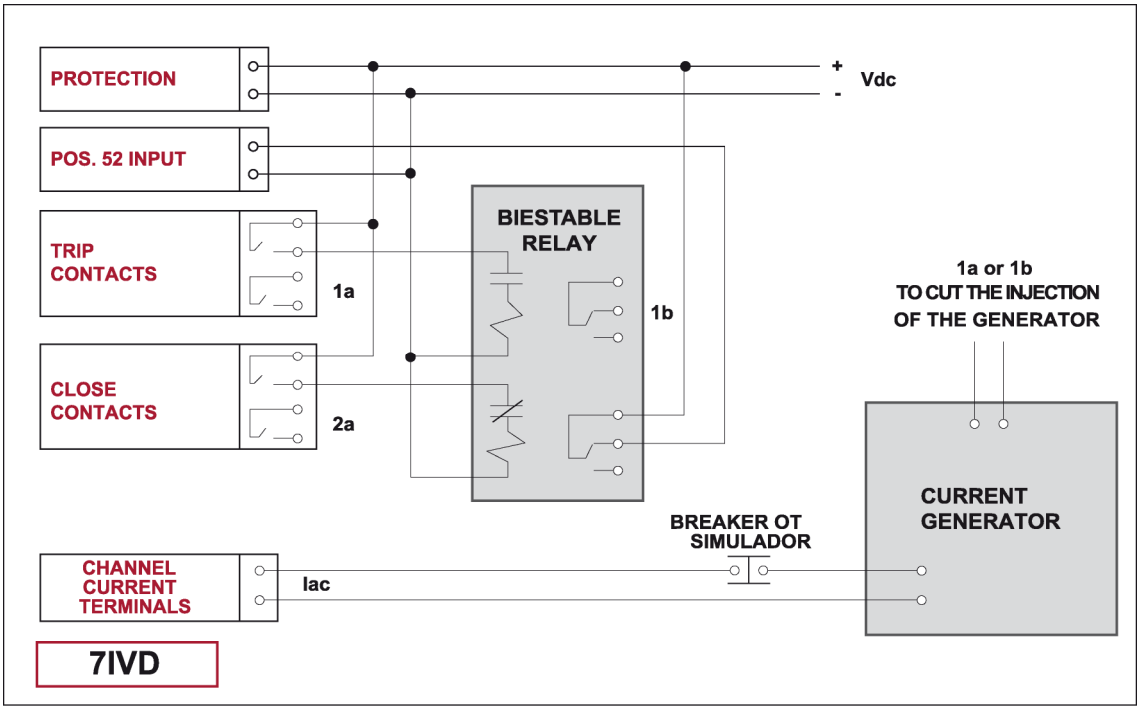

Figure 10.3:Connection Diagram for the Recloser Test.

Figure 10.3 shows how to perform the recloser test. If the current generator does not cut off the injection before the sequence check times out, you can perform the test either by opening the current circuit (with the breaker itself or by simulating it), or by causing an instantaneous element trip with a simple pulse. This may be enough for the instantaneous element to operate and, at the same time, to cease detecting current before the sequence check times out.

10.5.10 Trip / close Coil Circuit Supervision Input Test

To check that the switching circuits are properly monitored, you can observe the state of the inputs used on the screen, **Information** - **Status contact inputs**.

Both monitoring inputs of a circuit, whether for opening or for closing, must not be set to “1” or “0” at the same time. If they were, they would be in fault; that is, the two inputs must be in different states at any given time.

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10.6 Control Subsystem Receiving Tests

Each IED's control subsystem has a specific loaded configuration. These control subsystem receiving tests are not intended to check the control logic but rather the hardware associated with it, that is, metering values sent from protection, measures from converters or metering transformers, physical inputs, physical outputs and LED targets. This requires using the communications program with the control subsystem ***ZIVerlog***® to load a specific test configuration for each unit. If so desired, **ZIV** can provide this test configuration.

10.6.1 Test Configuration

- **Implementation of the test configuration**

This test configuration is an example for an IED with the following physical characteristics:

- Metering current processed by the protection CPU and sent to control
- 24 status contact inputs
- 17 auxiliary contact outputs
- 1 in service output

The control subsystem is configured thus:

- Measures: the current channel (A) measures appear on the measures screen.
- Logic / Inputs / Outputs: the inputs, outputs and LEDs are connected according to this scheme.
- The status contact inputs and physical outputs are designated according to the diagram of external connections (user). With this configuration loaded, run the following tests:
  - Status contact inputs test
  - Auxiliary contact outputs and LED targets test
  - Metering test

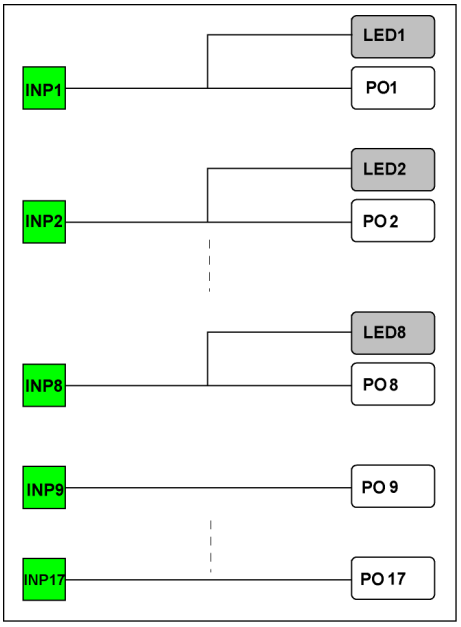

Figure 10.4: Test Configuration (I)

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If the unit is configured so that the number of inputs, outputs, LEDs and/or measurements does not match this example, the configuration design method is the same. The only difference will be the number of signals.

If the number of LED targets is less than eight, only the **L** first status contact inputs are to be connected to the LEDs, where **L** is the configuration's number of LED targets.

If the number of output signals exceeds the number of status contact inputs, modify the connections scheme so that a single input activates more than one auxiliary contact output. All the auxiliary contact outputs are checked as in the figure to the right:

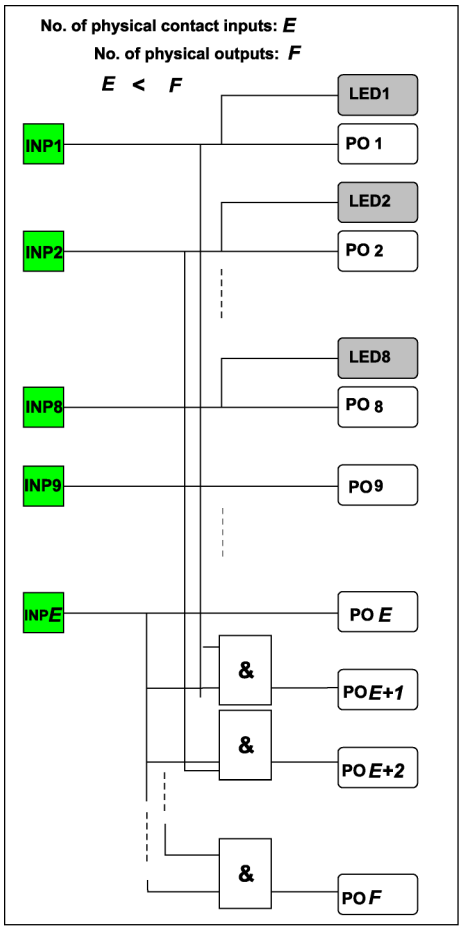

Figure 10.5: Test Configuration (II)

10.6.2 Status Contact Inputs Test

Connect a breaker to each of the control system's digital inputs.

Caution. Several available status contact inputs are coupled.

Sequentially activate each input and check that only the correct indicator becomes active on the **digital inputs** screen.

Repeat this process with every digital input in the IED.

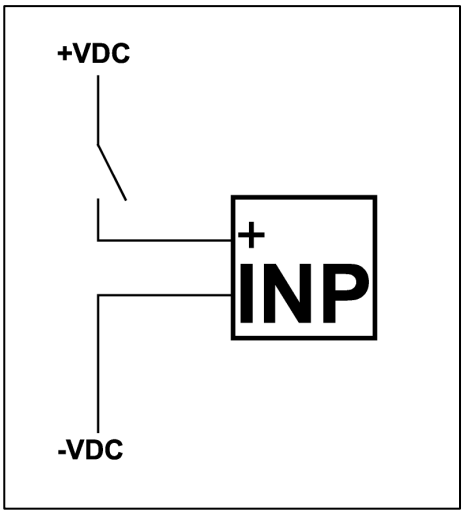

Figure 10.6: Connection for the Digital Inputs Test.

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10.6.3 Auxiliary Contact Outputs and LED Targets Test

Connect a breaker to each of the control system's digital inputs.

Caution. Several available status contact inputs are coupled.

Sequentially activate each input and check that only the indicator of the digital output with the same numerical index (or the correct one according to your connection scheme) becomes active.

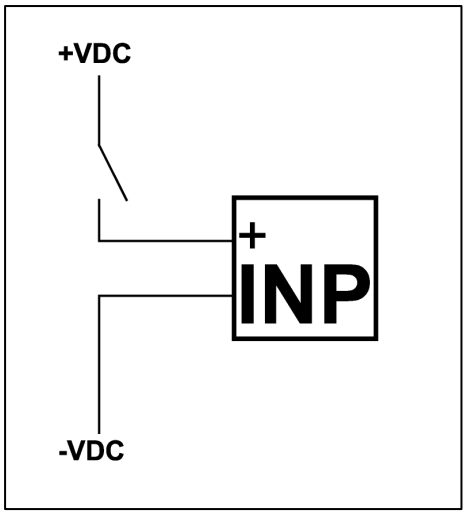

Figure 10.7: Connection for the Digital Outputs and LEDs Test.

10.6.4 Metering Test

This test checks whether or not the following measurements are correct: those collected by the protection or the measurement circuit board and sent to control, those collected through the input converters and those sent to the output converters. Therefore, this section is applicable when there is current or voltage metering or input converters.

- **Current measured values sent from protection or the measurement circuit board**

Connect an AC source to the current metering terminals for your model and check the measurements indicated in table 10-10. You can check these values via communications or on the measures screen in the graphic display.

Table 10-11: Current Measurement (Control)		
I Applied(A)	**I Measured (A)**	**CONV1 (mA)**
2.5	2.4875-2.5125	2.073-2.094
5	4.975-5.025	4.1458-4.1875
6	5.97-6.03	4.975-5.025

Check that the current described in the table matches the converter output.

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- **Voltage metering**

Connect a voltage source to the IED's voltage metering terminals and check the measured values against those of table 10-11 (for 50 Hz) or table 10-12 (for 60 Hz). You can check them via communications or on the measures screen in the graphic display.

Table 10-12: Voltage Measurement 50 Hz (Control)		
V Applied (V)	**V Measured (V)**	**CONV1 (mA)**
44	43.8 - 44.2	1.975 - 2.025
110	109.4 - 110.6	4.975 - 5.025
132	131.3 - 132.7	5.975 - 6.025

Table 10-13: Voltage Measurement 60 Hz (Control)		
V Applied (V)	**V Measured (V)**	**CONV1 (mA)**
48	47.75 - 48.25	1.975 - 2.025
120	119.4 - 120.6	4.975 - 5.025
144	143.3 - 144.7	5.975 - 6.025

Check that the converter output matches the current indicated in the table.

- **Input converters metering**

Apply direct current on the input converters and check the measured values against those of table 10-13 whenever the constant of the converter is at “1”. You can check these values via communications or on the measures screen of the display.

Table 10-14: Measuring the Input Transducers (Control)			
	Converters		
I Applied (mA)	**0 - 5**	**± 2.5**	**± 1**
X	X ± 0.025	X ± 0.025	X ± 0.005

10.7 Communications Test

To test the communications, first power up the relay with the rated voltage. The **available** LED should illuminate now.

Run this test through the front communications port, which has the following settings:

Baud rate: 4800 bauds
Stop bits: 1
Parity: 1 (even)

Use a DB9 (9-pin) serial connection wire to connect to the IED through the local communications port. Use the ***ZIVercom***© software program to synchronize the time. Disconnect the IED and wait for two minutes. Then reconnect the power supply and connect to the IED through the remote communications port. Activate the cyclical mode in the software program and verify that the time updates properly.

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10.8 Installation

10.8.1 Location

The location where the IED is to be installed should meet the following minimum conditions to ensure proper operation, long service life, ease of installation and ease of maintenance. These minimum conditions are the following:

- No dust
- No dampness
- No vibration
- Adequate lighting
- Easy access
- Horizontal mounting

Mount the equipment according to the installation dimensions drawings.

10.8.2 Connection

The first terminal of each auxiliary power supply terminal block, for example, terminals C1 and K1 (or F1 and X1, depending on the model), must be solidly grounded to ensure that the disturbance-filtering circuits operate properly. The wire used for grounding these IEDs should be stranded #14 AWG^2 – 2.5 mm^2. Ground wire length should be minimized and not exceed 12". Also make sure that the enclosure ground terminal located in the back of the unit is grounded.

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A. DNP 3.0 Communications Protocol

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Model-Specific Documentation for Equipment Using DNP 3.0 PROTOCOL

A.1 Physical Architecture

Figure A.1 shows the model **7IVD** option of two rear communications ports.

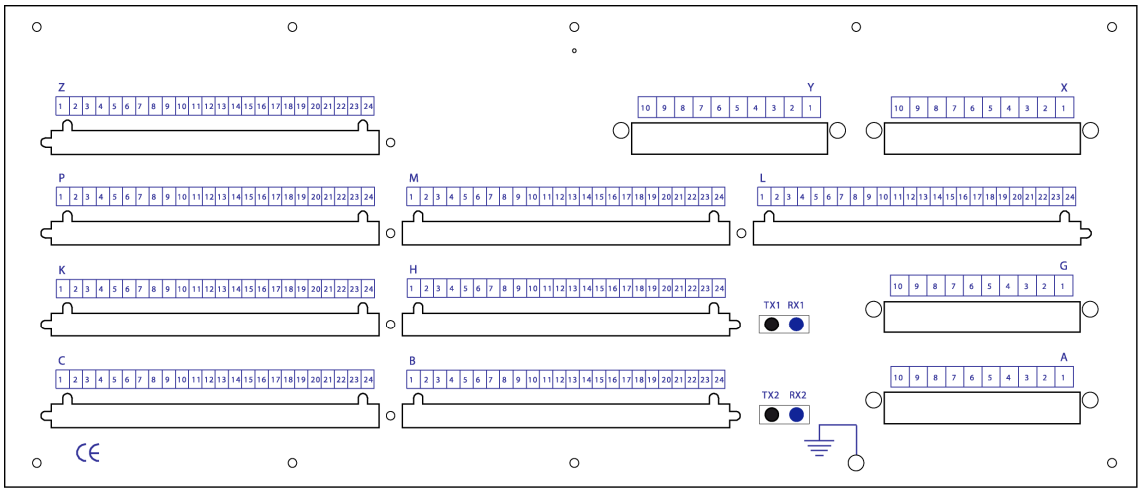

Figure A.1: Back of a 7IVD with Two Communications Ports.

A.2 Settings

DNP 3.0 Protocol Settings		
Setting	**Range**	**Step**
MTU Numer (Master equipment number)	0 - 65519	1
RTU Number (Slave equipment number)	0 - 65519	1
Enable unsolicited	0 - 1	
Reply Timeout L7	100 - 65535 ms	1 ms
Delay of Unsol	100 - 65535 ms	1 ms
L retries L7	0 - 3	1
Warning time	0 - 65535 ms	1 ms
Echo Control	0 - 1	
L retries L2	0 - 32	1
Fixed Delay	0 - 32767	1 ms
Max. Random Delay	0 - 32767	1 ms

Analog changes		
Setting	**Range**	**step**
% Measurement change Independent settings for measurement changes 0 to 15	0.00 - 100%	0.01 %

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A.3 Description of Operation

A.3.1 DNP 3.0 Protocol

The following settings configure models with the DNP 3.0 communications protocol:

- **DNP configuration settings**

The DNP 3.0 protocol configuration settings define:

MTU number

It specifies the address of the master station (**MTU** or **Master Terminal Unit**) that the **7IVD** will send the unsolicited or spontaneous messages to. It is used in combination with the enable unsol parameter. The 0xFFF0 to 0xFFFF addresses are reserved for the broadcast addresses.

RTU number

It specifies the address of the **7IVD** IED (acting as **RTU** or **Remote Terminal Unit**) in relation to to the rest of the IEDs that communicate with the same master station (MTU or Master Terminal Unit). The 0xFFF0 to 0xFFFF addresses are reserved for the broadcast addresses..

Habilitar Unsol

It enables (1-On) or disables (0-Off) the sending of spontaneous (unsolicited) messages. It is used in combination with the MTU number parameter. For the **7IVD** IED to begin sending spontaneous messages, the master must also enable them with the Function Code FC = 20.

Time out N7

It specifies the milliseconds that lapse from the time the **7IVD** sends a message requesting the master to confirm the application layer (level 7) until this confirmation is considered lost. The **7IVD** requests confirmation of the application layer when it sends spontaneous (unsolicited) messages or in response to requests for class 1 or class 2 data. When it times out, the message is retransmitted the number of times specified in L retries L7 parameter.

Delay of Unsol

It delays from the time an event is generated to the time the corresponding spontaneous (unsolicited) message is transmitted. This groups several events in a single message and saves bandwidth

L retries L7

Number of retries of the application layer (L7). The default value is 0 (zero), indicating that no retransmission will be attempted.

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Warning time

It is used in combination with the echo-control parameter to detect collisions on multi-drop lines (several devices connected to the same physical channel or communications line).

Echo control

It enables (1-On) or disables(0-Off) collision detection. It is used in multi-drop configurations. Set this parameter to 0-Off (default value) in point-to-point (peer-to-peer) communications.

Note: The warning-time and echo-control settings are used when several IEDs are connected to a concentrator of the CCY type working in multi-master mode.

- ### Measurement change

You can set 16 bands of AC measures (from 0 to 15). The setting is a percentage of the maximum value of the measurement. It is the referent to check whether or not there is an analog change to record. That is, a change will be recorded if the difference in AC measures exceeds the set percentage.

If you set it to 100%, no analog changes of that measurement will be recorded. This amounts to disabling it.

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- **Implementation table**

OBJECT			REQUEST (7IVD will parse)		RESPONSE (7IVD will respond)		
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**	**Notes**
1	0	Binary Input – All variations	**1**	0x6			
1	1	Binary Input			129	0x1	Assigned to Class 0
2	0	Binary Input Change – All variations	1	0x6,7,8			
2	1	Binary Input Change without Time	1	0x6,7,8			B
2	2	Binary Input Change with Time	1	0x6,7,8	129,130	0x28	Assigned to Class 1
2	3	Binary Input Change with Relative Time	1	0x6,7,8			B
10	0	Binary Outputs – All variations	1	6			A
12	1	Control Relay Output Block	3,4,5,6	**0x**17,28	129	Echo of request	
20	0	Binary Counter – All variations	1	0x6			A
21	0	Frozen Counter – All variations	1	0x6			A
22	0	Counter Change Event – All variations	1	0x6,7,8			B
30	0	Analog Input – All variations	1	0x6			
30	2	16-Bit Analog Input			129	1	Assigned to Class 0
32	0	Analog Change Event – All variations	1	0x6,7,8			
32	4	16-Bit Analog Change Event with Time			129,130	0x28	Assigned to Class 2
40	0	Analog Output Status – All variations	1	0x6			A
41	2	16-Bit Analog Output Block	3,4,5,6	0x17,28			A
50	1	Time and Date	2	0x7 count=1	129		C
52	2	Time Delay Fine	23		129	0x7 count=1	F,G

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OBJECT			REQUEST (7IVD will parse)		RESPONSE (7IVD will respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
60	1	Class 0 Data	1	0x6	129	0x01	
60	2	Class 1 Data	1	0x6,7,8	129	0x28	D
			20,21	0x6			
60	3	Class 2 Data	1	0x6,7,8	129	0x28	D
			20,21	0x6			
60	4	Class 3 Data	1	0x6,7,8			B
80	1	Internal Indications	2	0x0 index=7			E
--	--	No Object (Cold Start)	13				F
--	--	No Object (Warm Start)	14				F
--	--	No Object (Delay Measurement)	23				G

Notes:

A: The IED's level of implementation does not support this group and object variation or, for static objects, it does not have objects with this group and variation. OBJECT UNKNOWN response (IIN2 bit 1 active).

B: No range of points is specified, and the IED does not have objects of this type. Null response (no IIN bit active, simply no response is made to any object of the type specified).

C: The unit supports write operations on "time and date" objects. The "Time Synchronization-Required Internal Indication" bit (IIN1-4) will be set to zero in the response.

D: The unit can be configured for sending or not sending unsolicited responses. You can access a configuration option through the human-machine interface or front-panel user interface. Once the unsolicited option is enabled, the master can enable or disable unsolicited messages (for classes 1 and 2) by means of requests (FC 20 and 21).
If unsolicited response mode is enabled, then after restarting the unit, it will transmit an initial Null unsolicited response, requesting confirmation from the application layer. While awaiting the confirmation from the application layer, the unit will respond to all request functions, including READ requests.

E: The master can explicitly set the "Restart Internal Indication" bit (IIN1-7) to zero.

F: The remote station, after receiving a Cold or Warm Start request, will respond by sending a "Time Delay Fine object" message (which specifies an interval of time until the remote station will be ready for more communications), reinitiating the process and setting DNP bit IIN1-7 (Device Restart).

G: The IED supports "Delay Measurement" requests (FC = 23). It responds with the "Time Delay Fine object" (52-2). This object sets the number of milliseconds to transpire between the remote station's reception of the first bit of the first byte of the request and the transmission time of the first bit of the first byte of the response

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- **Specific characteristics of the IED**

There is a "Time window" (“Delay of unsolicited request” setting) between the generation of an event and the subsequent transmission of the unsolicited message). This is done to group various events in one message and save bandwidth.

Internal indication IIN1-6 (Device trouble): It activates to indicate a change in the current DNP configuration of the remote station. It deactivates in the next response. It is used to let the master station know that the DNP settings have changed in the remote station. Note that some erroneous configurations could render it impossible to communicate this condition to a master station.

This "Device profile document" also declares the DNP 3.0 settings available in the unit. If the user changes any of these settings, the “Device trouble internal indication” bit will activate in the next response sent.

Event files: the IED can store up to 50 “Binary input changes” and 50 “Analog input changes.” If the IED's limits are reached, the “Event buffers overflow internal indication” bit will be enabled in the next response sent. It will be disabled when the master reads the changes, making room for new ones.

The metering values (16-Bit Analyte Input) sent by communications depend on each control model, and their scale readings are:

Type of measure	Scale reading	Value sent
Currents	6 AAC	32767 counts
Voltages	132 (50Hz) or 144 (60HZ) V_{AC}	32767 counts
Powers	± 2376 (50Hz) or 2592 (60HZ W / Var / Va	± 32767 counts
Power factor	± 1	± 32767 counts
Frequency	40 – 70 Hz (With a measurement circuit board: 0 – 72 Hz)	0 - 32767 counts

The scaling of the ***distance*** value is:

- 20 % --- 100 % escaling to **0 --- 32767 (16 bits)**

So that:

Measure	Value sent	Meaning
<-20 %	0	Invalid value (quiescent)
- 20 %	0	Invalid value (quiescent)
-20 ÷ 0 %	0	Invalid value (quiescent)
0 %	6553	Distance from 0%
100 %	32767	Distance from 100%
>100 %	0	Invalid value (quiescent)

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A.3.2 Communications

A.3.2.a Communicating with the 7IVD

7IVD models can have an optional second rear port of plastic optical fiber.

A.4 Alphanumeric Keyboard and Display

A.4.1 Change Settings

From the **Settings** menu (Control operation mode), the option **DNP 3.0 Protocol** can be selected.

- General Settings.
- Time Settings.
- Logic Settings.
- Analogic Settings.
- DNP 3.0 Protocol Settings.

0 - GENERAL
1 - TIMER
2 - LOGICS
3 - ANALOGICS
4 - DNP 3.0 PROTOCOL

Then, the password is introduced via the keypad. If the password is correct, further options corresponding to this next level are displayed:

A.4.2 DNP3.0 Protocol

Selecting DNP 3.0 Protocol option, a screen with the following options appears: **Configuration**, **Metering Changes (Deadband Values)** and **EDC Local-Telecomand**.

0 - DNP CONFIGURATION
1 - DEADBAND VALUES
2 - LOCAL-TELECOMAND

- **DNP 3.0 Configuration**

Selecting first option **DNP 3.0 Configuration**, the following options appears: **RTU Address**, **Reply Timeout N7**, **N7 Retry Counter**, **Enabl Unsol Report**, **MTU Address**, **Unsol Delay Report**, **Echo Ctrl Enable**, **N2 Retries**, **Pre-Transm. Time**, **Fixed Delay** and **Max. Random Delay**.

0 - RTU ADDRESS
1 - REPLY TIMEOUT N7
2 - N7 RETRY COUNTER
3 - ENABL UNSOL REPORT
4 - MTU ADDRESS
5 - UNSOL DELAY REPORT
6 - ECHO CTRL ENABLE
7 - N2 RETRIES
8 - PRE-TRANSM. TIME
9 - FIXED DELAY
10 - MAX. RANDOM DELAY

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- **Metering Changes (Deadband Values)**

The second option, **Deadband Values**, presents the posibility to adjust independently the analogic meterin bands (according to equipment and model).

- **EDC Local-Telecomand**

The third option presents the posibility to adjust the selection mode of the calculated digital status (**EDC**) as **local / telecomand**. The options are **fixed** or **EDC input**.

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B. Models with a Fault Locator

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Specific Information for Models with a FAULT LOCATOR

B.1 Settings

B.1.1 Locator Settings

Line values		
Setting	**Range**	**Step**
Positive sequence magnitude (Z_1)	0.01 - 50 Ω	0.01
Positive sequence angle	15 - 90 º	1
K0 factor (zero sequence compensation) ($Z_0 = k_0 \times Z_1$)	1.00 - 8.00	1
Zero sequence angle	15º - 90 º	1
Line length	0.00 - 400.00	0.01
Line length units	Kilometers / Miles	
Locator units	Length unit / %	
Permanent indication	YES / NO	
Duration of the indication	1 - 120 min	1 min
Minimum value of zero sequence current ($3 \times I_0$)	0.00 - 500.00 A	0.01 A

B.2 Description of Operation

B.2.1 Fault Report

Each fault report in the **Fault Report Record** contains the following information:

Fault Initiation Time Tag. It presents the date and time of the pickup of the first element involved in the fault. It also includes:

- Pre-fault currents and voltages. They are the values of the three-phase and ground currents and of the voltages of the three phases and of the ground as well as of the inverse sequence and zero sequence currents, two cycles before the initiation of the fault.
- Elements picked up for full fault duration.

Open command time tag. It presents the date and time of the trip command. It also presents:

- Intensities of the three phases and the ground and voltages of the three phases and of the ground as well as of the inverse sequence and zero sequence currents, two and a half cycles after the initiation of the fault.
- Tripped elements.
- Distance to the fault and type of fault.

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Fault end time tag. It is the date and time of the reset of the last element involved in the fault. It also presents:

- Current interrupted by the breaker: it is the maximum phase current registered between the instant the trip command is given and the termination of the fault (due to the breaker opening or to failure of the open command).

Each record of the fault report also includes the active group at the time of the trip and the reclose sequence of the IED at the time of the pre-fault.

B.2.2 Fault Locator (Operation)

The **Fault Locator** uses the phase selector to determine the type of fault. Then the algorithm for each type of fault determines the distance to the fault.

The fault locator uses two main algorithms. The first determines whether the fault is three-phase. This requires three concomitant conditions:

1) High direct-sequence component, that is, above **0.1 In A**.

2) Low inverse-sequence component: meaning no more than **0.05 I_n A** and **5%** of the direct-sequence component.

3) Low zero-sequence component: no more than **0.05 I_n A** and **5%** of the direct-sequence component.

If the fault detected does not comply with all the conditions of a three-phase fault, the second phase selector algorithm is executed. It compares the arguments of the inverse and direct cycles.

If the fault is not three-phase and meets the third condition for three-phase faults (low zero-sequence component), it cannot be a ground fault. Therefore, it can be considered two-phase. If, however, it does not meet the third condition for three-phase faults (high zero-sequence component), it must be a ground fault. Therefore, it can be considered single-phase or two-phase to ground.

Faulted phases are determined by analyzing the angle: $\phi = \arg(Ia2) - \arg(Ia1\_f)$ where:

Ia2: Phase A inverse sequence current.
Ia1_f: Faulted phase A direct sequence current (once the load component is eliminated).

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These figures are the angle diagrams used in determining the faulted phases by angle. ∅.

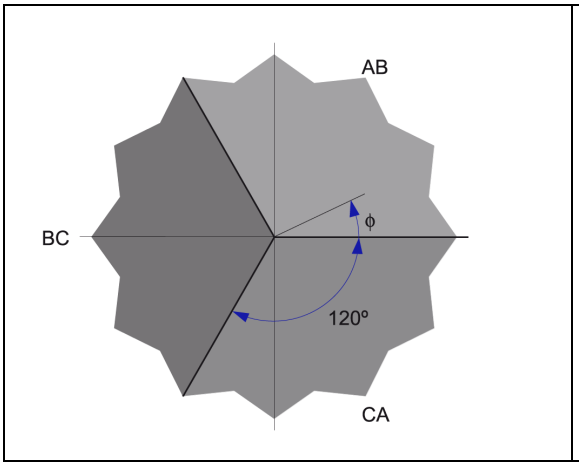

Figure B.1: Angle Diagram for Two-Phase Faults.

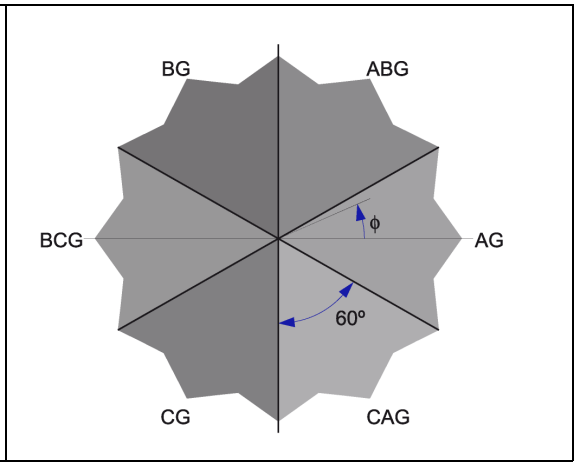

Figure B.2: Angle Diagram for Single-Phase and Two-Phase-to-Ground Faults.

B.2.2.a Fault Locator (Setting)

As indicated in section B.1, Settings, the fault locator has two settings for sending the distance through remote communications (in the control profile):

Permanent indication: YES / NO
Duration of the indication: 1 - 120 min

The following straight line governs the locator measurements sent in the control profile:

Figure B.3: The scale of the Locator Measurements in the Control Profile.

Distances: -20% → 0 counts (invalid value)
Distances: 100% → 4095 counts

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If the distance that the locator calculates is greater than 100% or is less than 0%, the measurement sent in the control profile is 0 counts. The IED display and the fault report, however, will indicate: **> 100%** and **< 0%** respectively.

If the permanent indication setting is NO, the locator takes the **Duration of the indication** setting into account for sending the distance through the communications profile. When a fault report occurs, the indication of the distance through the control profile lasts the time set. If a new fault occurs meanwhile, the distance sent by communications is still that of the first fault. When the set time transpires, an **invalid** value for the distance (0 counts, corresponding to –20%) is sent. Now if a new fault occurs the distance to this last fault is sent. In contrast, the last trip indication in the display and the fault report always show the locator's distance for the last trip produced.

If the permanent indication setting is YES, communications always sends the distance of the last fault registered. If the relay has not registered a fault, it will be sending an **invalid** *value* (0 counts).

Also as stated in section B.1, Settings, the fault locator has a setting to block distance-to-fault calculation for single-phase faults with 3 x I_0 values below the setting two and a half cycles after the pickup. The fault will be classified as an **UNKNOWN FAULT**:

Minimum value of zero sequence current: 0 – 500A

This setting refers to primary values.

Any fault occurring during the 15 cycles after the breaker closes will also be classified as an **UNKNOWN FAULT**. This logic only considers the breaker status change. It makes the locator insensitive to the inrush currents of the transformers that are energized when the breaker closes.

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B.2.2.b Location Information

- **From the display**

You can set the distance-to-the-fault indication to length units (kilometers or miles) or a percentage of the line length (see Chapter 7, Alphanumeric keypad and display). The default screen will indicate this distance when there is a fault.

- **Via communications**

You can access the distance to a fault through the communication ports. Look for it in the **fault report**. Depending on the setting, this distance will be expressed in length units or as a percentage of the line length.

You can also send it through the control port by means of the communications protocol implemented in CONTROL (PROCOME or DNP3). In this case, it will be expressed as a percentage.

There are two **locator** settings in the **Line values** menu (see Chapter 8, Alphanumeric keypad and display) for transmitting the distance to the control protocol: **Permanent indication** and **Duration of the indication**.

If the **permanent indication** setting is **YES**, the value of the variable will not change until a new fault report is stored. Then it will change to the new value.

If, on the contrary, the setting is **NO**, the measurement variable will remain for the time specified in the **Duration of the indication** setting. If another fault report is stored while this time is being calculated, the value of the new calculated distance will not be sent to the control protocol. When the **Duration of the indication** time transpires, a null value will be transmitted and the system will be ready to transmit new distance information when there is another fault report.

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B.3 Description of Operation of the Control Subsystem

B.3.1 Functional Characteristics

Besides the control functions indicated in Chapter 7, you have.

B.3.2 Control Unit

B.3.2.a Inputting Data to the Control Subsystem

- **Inputs from the protection subsystem**

Distance to the fault

The distance-to-fault measurement is sent directly to the central unit via communications. It is also shown on the corresponding screen of the graphic display (see section B.5).

B.3.2.b Outputting Data from the Control Subsystem

- **Signals sent to the protection subsystem**

In IEDs with a **fault locator**, a command can be sent to the protection subsystem to initialize (to zero) the distance-to-fault value calculated after the last trip (**Distance reset**). The logic generates this command if it is assigned by the **output connection system**.

B.4 Alphanumeric Keyboard and Display

B.4.1 Using the F2 Key to Access the Functions

B.4.1.a Last trip Indication and Recloser State

In IEDs with the **Fault Locator** option, the number of reclose attempts is replaced by the distance to the fault indication expressed as a percentage of line length or in length units (depending on the predetermined setting).

The messages that the **Fault Locator** can present in the display depend on the calculations that it performs: The possibilities are:

- Negative distances: The display shows the message, **DIST<0**.
- Distances within the line defined (0 to 100%): the corresponding distance is indicated.
- Distances that surpass 100% of the line length: The display shows **DIST>100**.
- When the LOCATOR lacks information for calculating the distance the *display* shows **UNKNOWN FAULT.**
- While the distance is being calculated: the display shows the message, **CALCULATING DISTANCE**.

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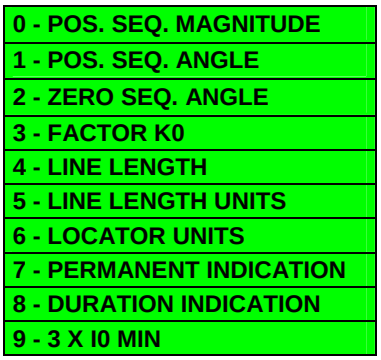
B.4.2 Locator Settings

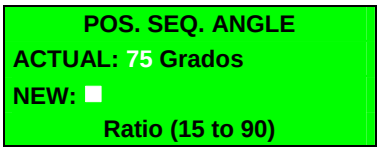
After you select the **Locator** option from the **Modify settings** menu, the screen presents the **Line values** and **Locator configuration** settings.

The setting options are: **Positive sequence magnitude**, **Positive sequence angle**, **Zero sequence angle**, **K0 factor**, **Line length**, **Line length units**, **Locator units**, **Permanent indication**, **Duration of the indication** and **Minimum value of zero sequence**.

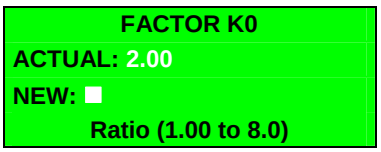

0 - POS. SEQ. MAGNITUDE
1 - POS. SEQ. ANGLE
2 - ZERO SEQ. ANGLE
3 - FACTOR K0
4 - LINE LENGTH
5 - LINE LENGTH UNITS
6 - LOCATOR UNITS
7 - PERMANENT INDICATION
8 - DURATION INDICATION
9 - 3 X I0 MIN

Selecting the **Positive Sequence Magnitude** setting brings up a screen for changing the line impedance of this module.

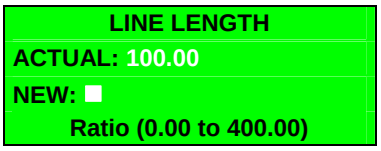
The next setting, **Positive Sequence Angle**, allows you to vary the angle of this module. The **Zero Sequence Angle** setting is identical to this one.



The **K0 Factor** setting allows you to define the zero sequence compensation factor.

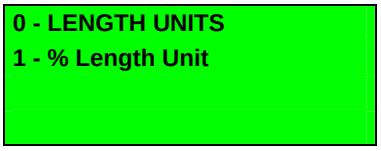


The fourth line values setting is the **Line Length** that the locator operates on



Use the next setting, **Line Length Units**, to set the unit of length, kilometers or miles, for expressing the preceding setting.

The last line values setting is **Locator Units**. Use it to choose between line length units or a percentage of the line length. When there is a fault, the locator will express the measurements according to this setting.



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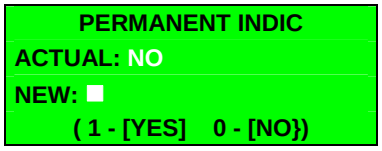
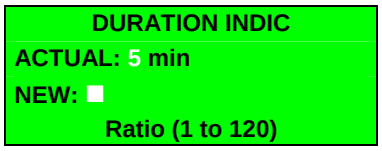
Permanent indication and Duration of the indication

Once the distance to the fault is calculated, the location measurement variable will maintain the value calculated for some time. This time depends on the **Permanent indication** and **Duration of the indication** settings.

If the **Permanent Indication** setting is **YES**, the value of the variable will not change until a new fault report is stored. Then it will change to the new value. In this operation mode, the location measurement will always be the value calculated for the last fault report stored.

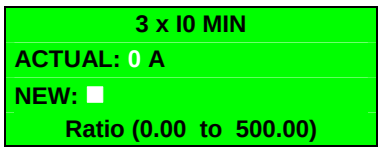


If, on the contrary, the **Permanent Indication** setting is **NO**, the measurement variable will maintain the value for the time defined in the **Duration of the Indication** setting. If another fault report is stored meanwhile, the corresponding distance to the fault is not stored in the location measurement variable, although it is stored in its corresponding fault report record.



Minimum Zero Sequence Value

You can set a zero sequence current (3 X I_0) threshold value for single-phase faults. This way, if two and a half cycles after the pickup of the first element the 3 x I_0 magnitude is less than this setting, the fault will be classified as an **unknown fault**. The setting is **Minimum zero sequence value** and it refers to primary values.



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B.5 Local Control Graphic Display

B.5.1 General

A new function is added to the function key **I** :

Functions	Serigraphy	Color
Close / In service / Automatic / Remote Control / Distance Reset	I	Green

B.5.2 Symbols Used in the Graphic Display

You can customize how the display represents the object that allows initializing (to zero) the value of the distance calculated after the last fault. This does not depend on the state of any input signal. It will act like a push-button. When you select it and operate on it, it stays *pressed* for 2 s and then returns to its default state.

B.5.3 Accessing the Information

B.5.3.a Measurement Information

The internal divisions of the measurement screens shown in Chapter 9 are eliminated for the values received from protection as well as those read by the metering circuit board.

IEDs with **fault locator** include the distance-to-fault protection measurement. It is always presented as a percentage and when there is no valid value (0-100%), **d =**.**%** appears.

B.5.4 Operation of the Control Functions

B.5.4.a Control Procedure for other Logic Devices

The operation of the logic device that allows resetting the distance-to-fault value follows the established general procedure. After you select it with the **NXT** key, you must press the I key before 10 seconds transpire. Then the object associated with this device will remain active ≈ 2 s.

When this command is executed, the IED will initialize (to zero) the calculated distance-to-fault value after the last protection trip that has generated this information.

In this type of commands, what is established for **COMMAND FAILURE** will not apply since no applicable return signal exists.

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C. Schemes and Drawings

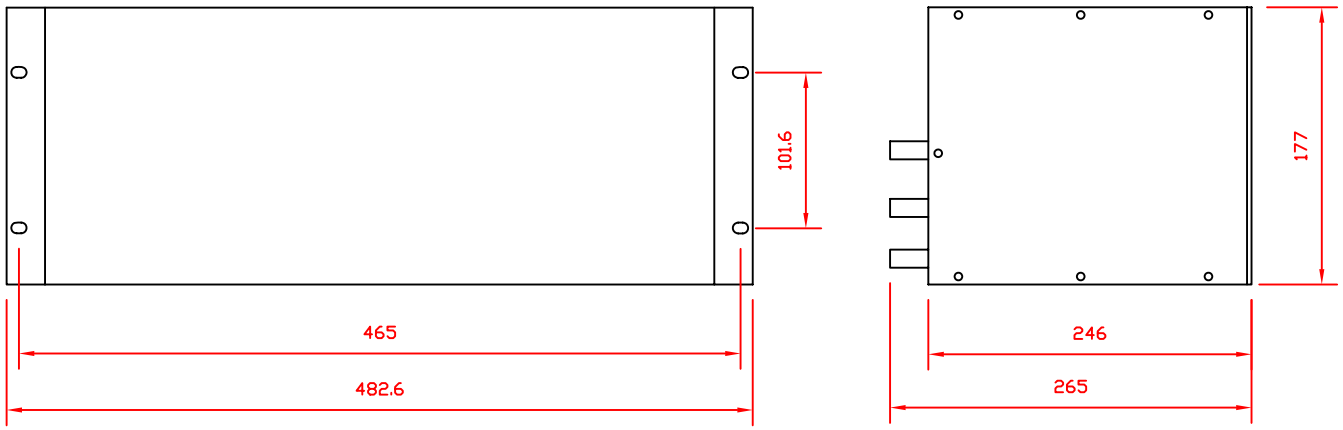
Dimension and drill hole schemes

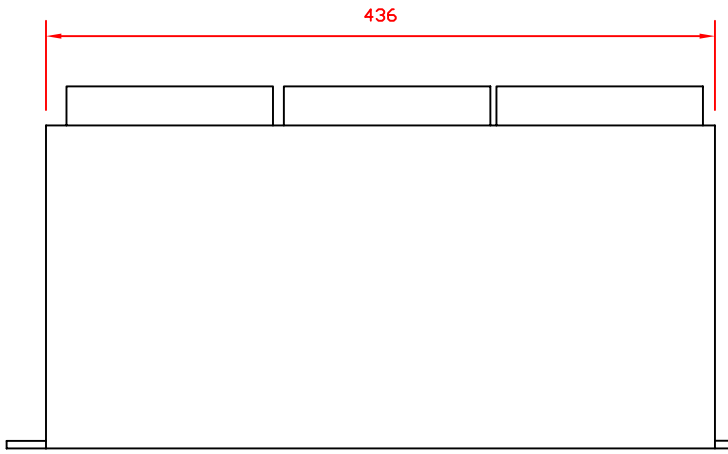
7IVD (4U x 19” 1 rack)	>>	4BF0100/0012

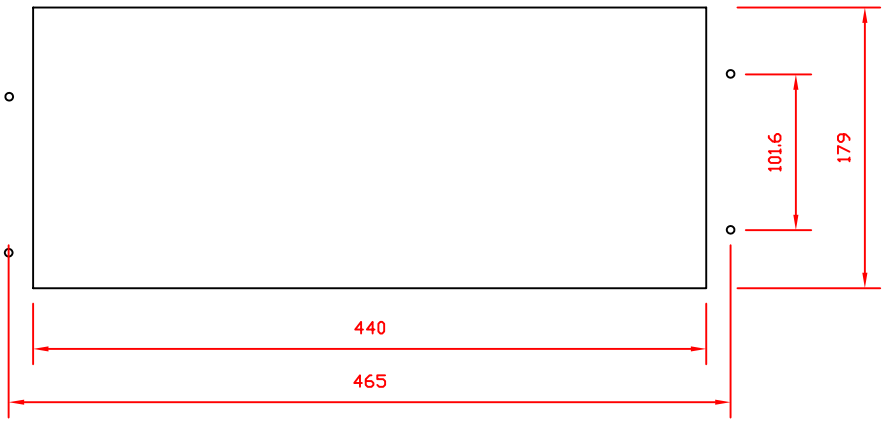
External connection schemes

7IVD-J	>>	3RX0139/0039
7IVD-K	>>	3RX0139/0042
7IVD-L	>>	3RX0139/0041

CAJA TIPO "K" Y "Q"
CAIXA TIPO "K" Y "Q"
BOîTIER TYPE "K" ET "Q"
ENCLOSURE TYPE "K" AND "Q"







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FUROS 8mm ø
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REVISIONES					
	0		1	CDN9506107	
2	CDR9510101	3	CDR9710100	4	CDR9809104
5	CD9911149	6	CD0202125	7	CD0411139
8	CD0901130	9		10	
11		12		13	
14		15		16	

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Rev. 3 2/10/97
Rev. 4 10/9/98
Rev. 5 19/11/99
Rev. 6 14/2/02
Rev. 7 19/11/04
Rev. 8 6/2/09

Z I V Aplicaciones y Tecnologia S.A.

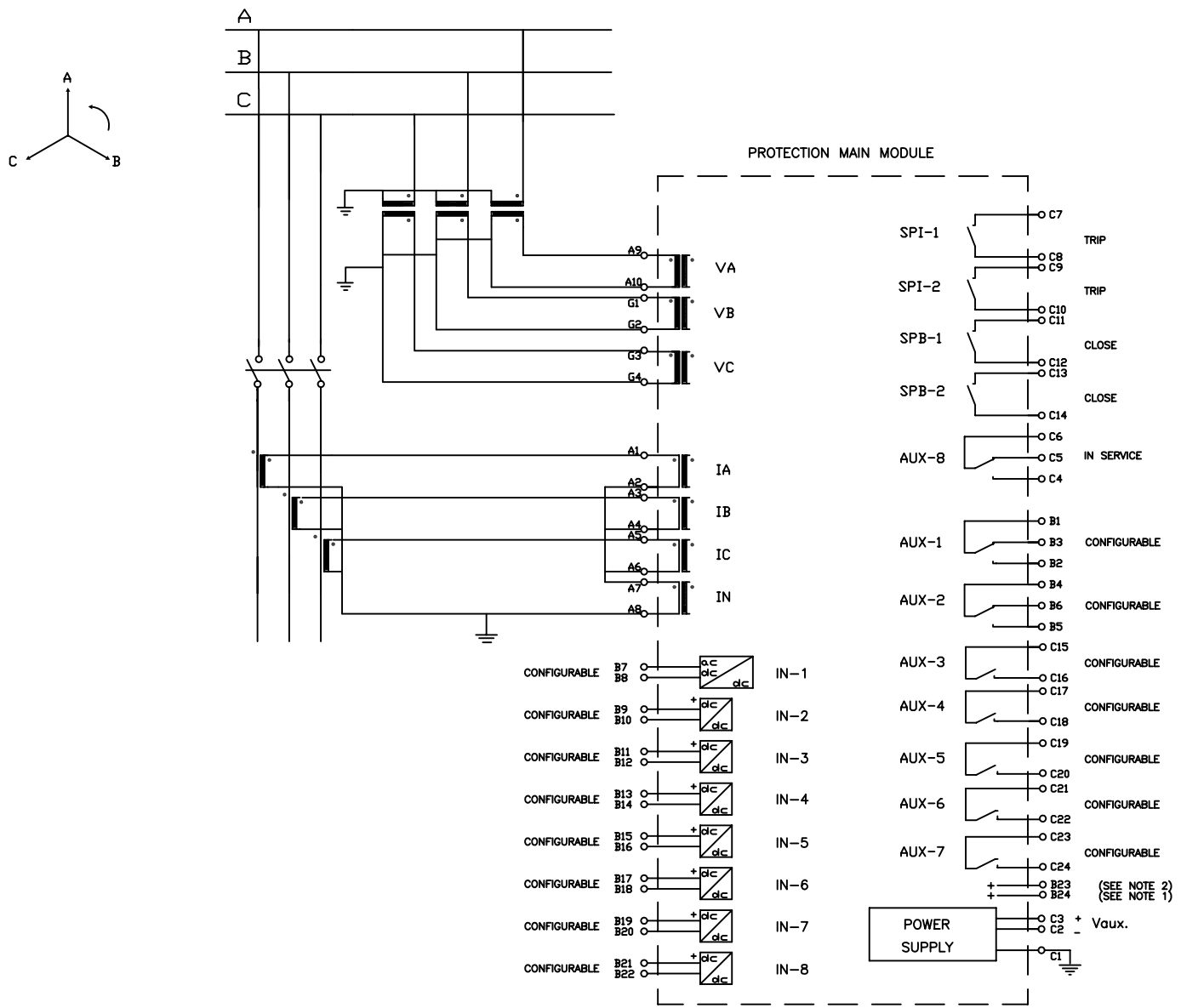
TITULO: DIMENSIONES Y TALADRADO

PROYECTO: CAJA TIPO "K" Y "Q" 4U 1RACK

NUMERO: 4BF0100/0012

	Fecha	Nombre
Dibujado	27/6/95	R.O.
Aprobado	27/6/95	R.O.

Hoja: 1
Continua en Hoja:



LEDS

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NOTE 2: TERMINAL B23 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN7, IN8) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION

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TITLE: EXTERNAL CONNECTIONS 7IVD–J(40)

PROJECT: OVERCURRENT/VOLTAGE PROTECTION

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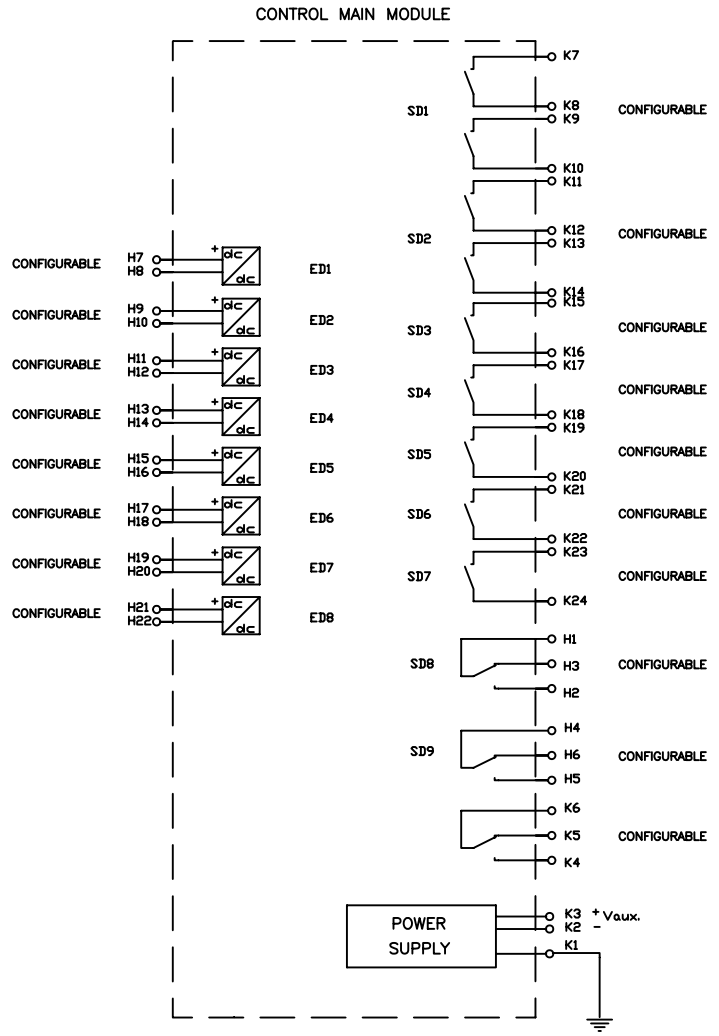

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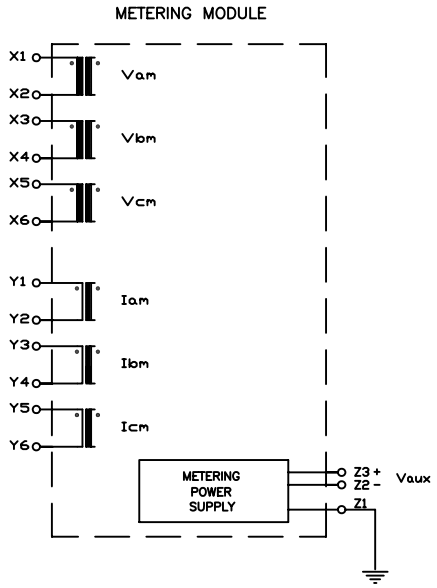

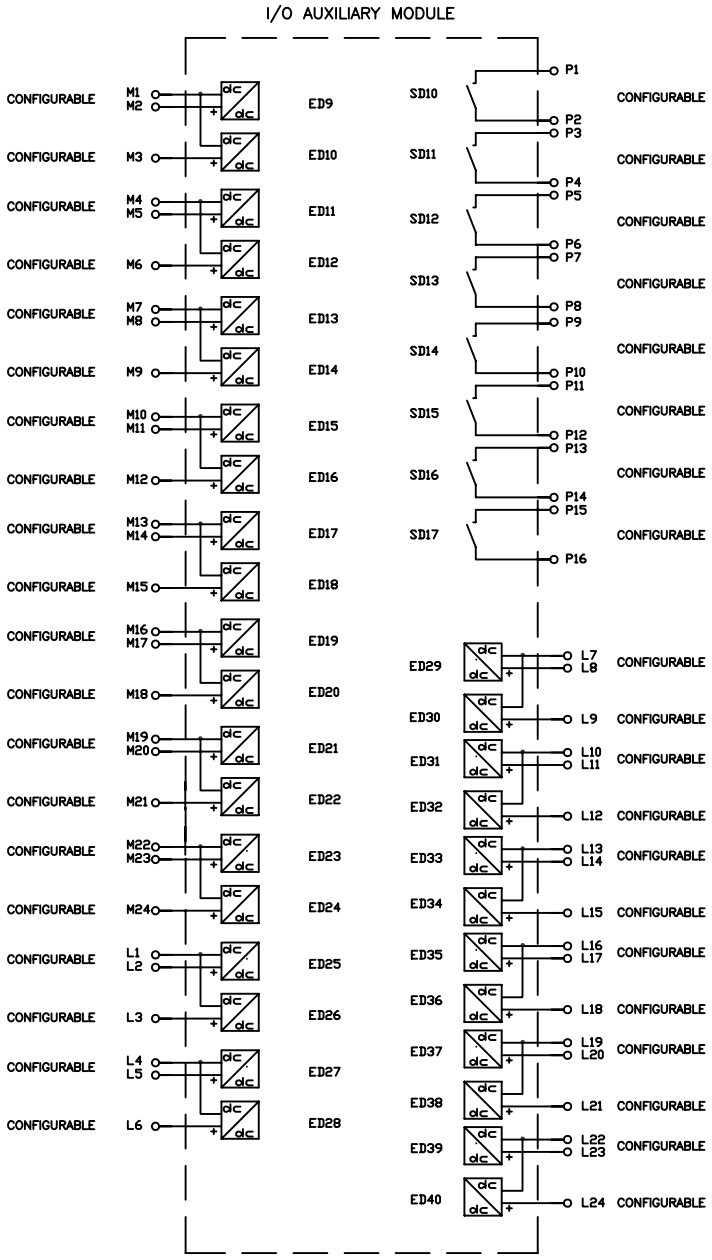

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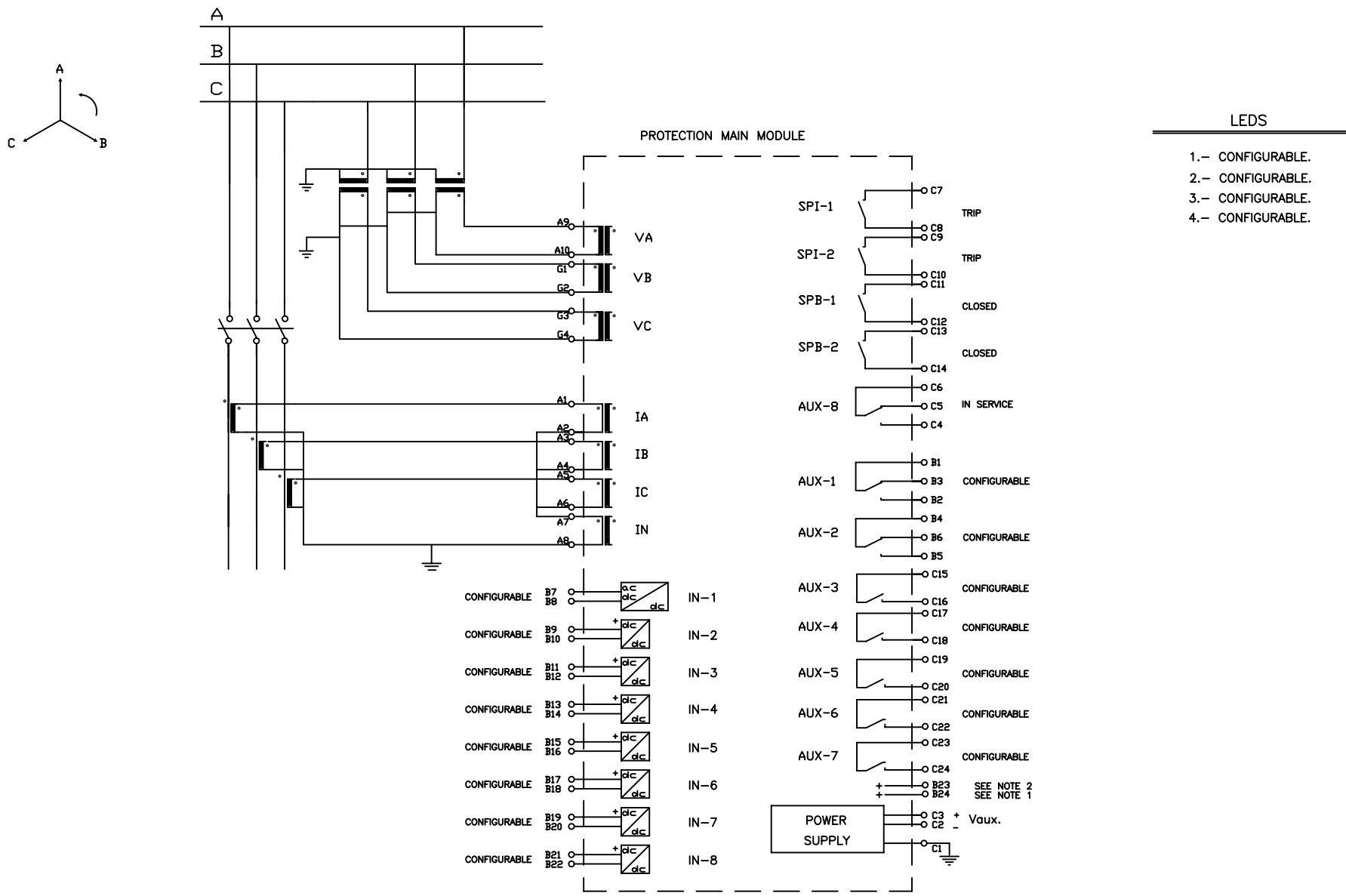

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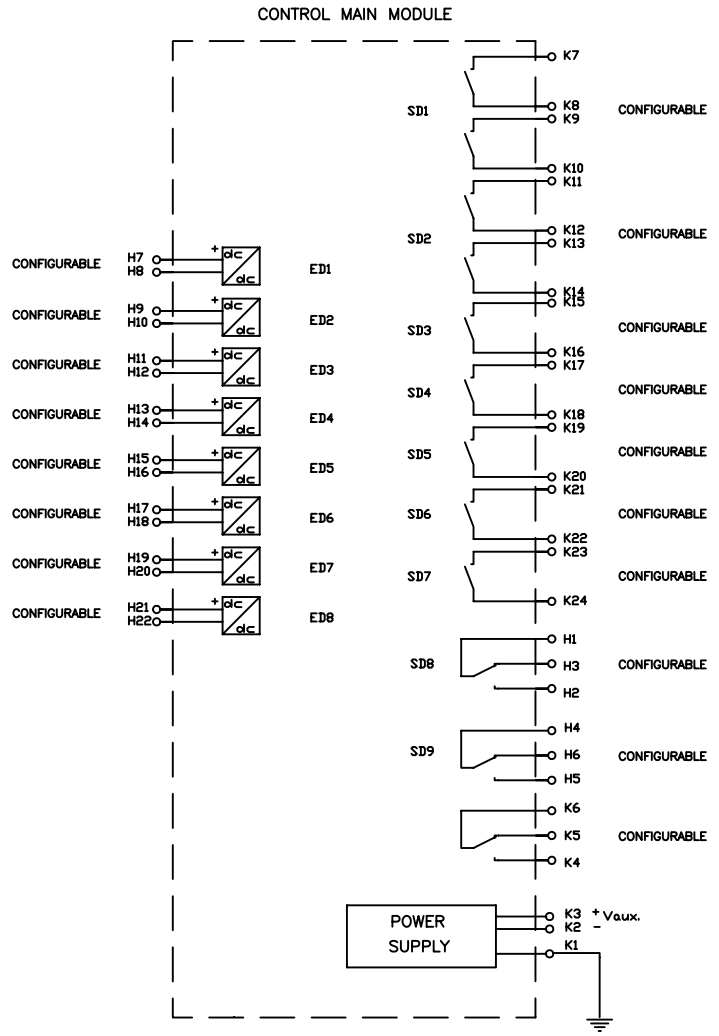

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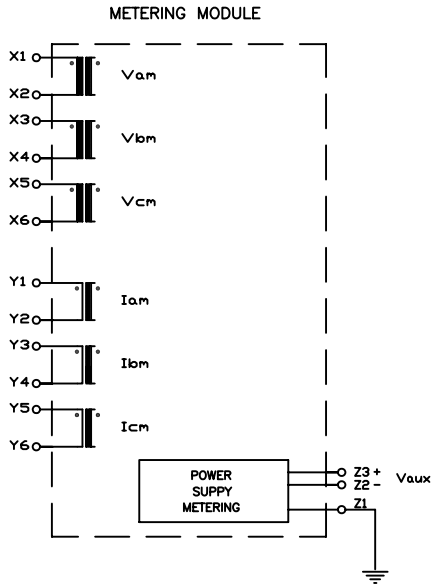

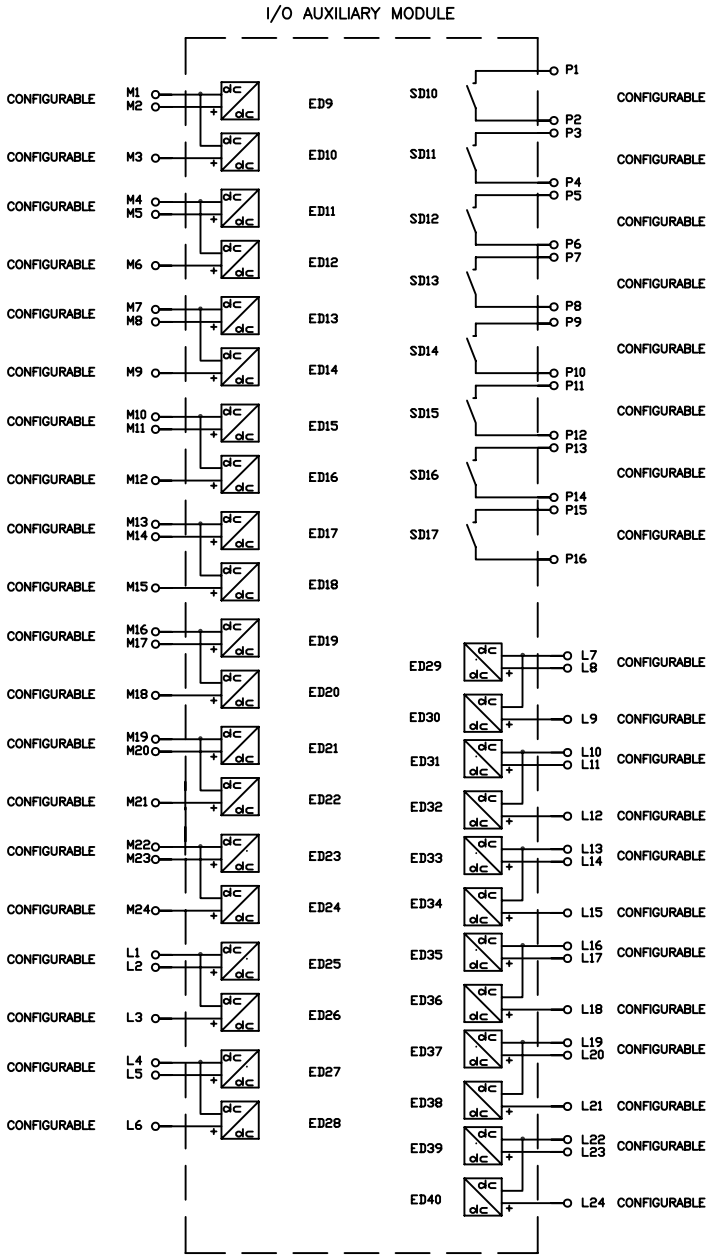

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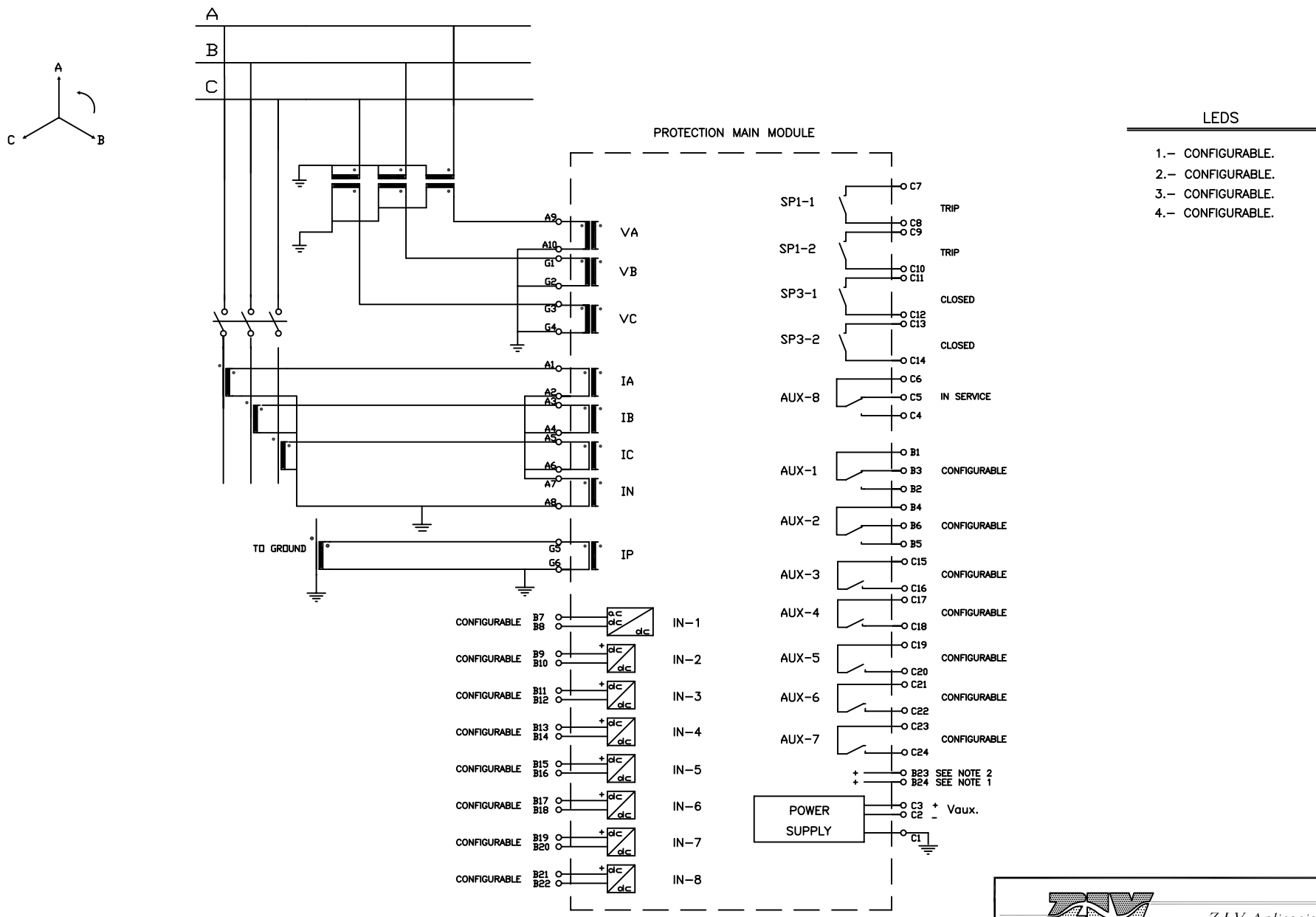

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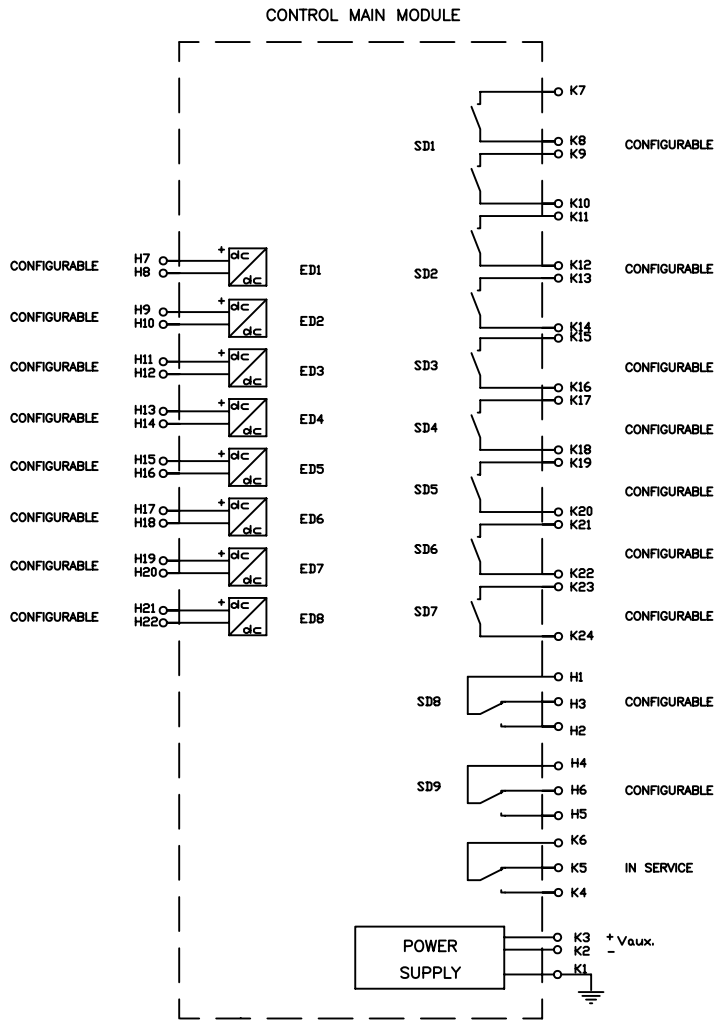

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TITULO: EXTERNAL CONNECTIONS 7IVD-L(58)

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E. Warranty

ZIV GRID AUTOMATION, S.L.
Standard Product Warranty

All new products sold to customers are warranted against defects in design, materials, and workmanship for a period of ten (**10**) years from the time of delivery (at the moment the product leaves ZIV GRID AUTOMATION premises, as indicated in the shipping documents). Customer is responsible of notifying ZIV GRID AUTOMATION of any faulty conditions as soon as they are detected. If it is determined that the new product defect is covered by the warranty, ZIV GRID AUTOMATION will repair, or substitute the product at its own discretion to the customer at no charge.

ZIV GRID AUTOMATION may, at its own discretion, require the customer to ship the unit back to the factory for diagnosis before making a determination as to whether it is covered by this warranty. Shipping costs to the ZIV GRID AUTOMATION factory (including but not limited to, freight, insurance, customs fees and taxes, and any other expenses) will be the responsibility of the customer. All expenses related to the shipment of the repaired or replacement units back to the customer will be borne by ZIV GRID AUTOMATION.

Customers are responsible for all expenses related to the shipment of defective units back to ZIV GRID AUTOMATION when it is determined that such units are not covered under this warranty or that the fault is not ZIV GRID AUTOMATION´s responsibility. Units repaired by ZIV GRID AUTOMATION are warranted against defects in materials, and manufacturing for a period of one (1) year from the time of delivery (at the moment the product leaves ZIV GRID AUTOMATION premises, as indicated by the shipping documents), or for the remaining of the original warranty, whichever is greater.

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